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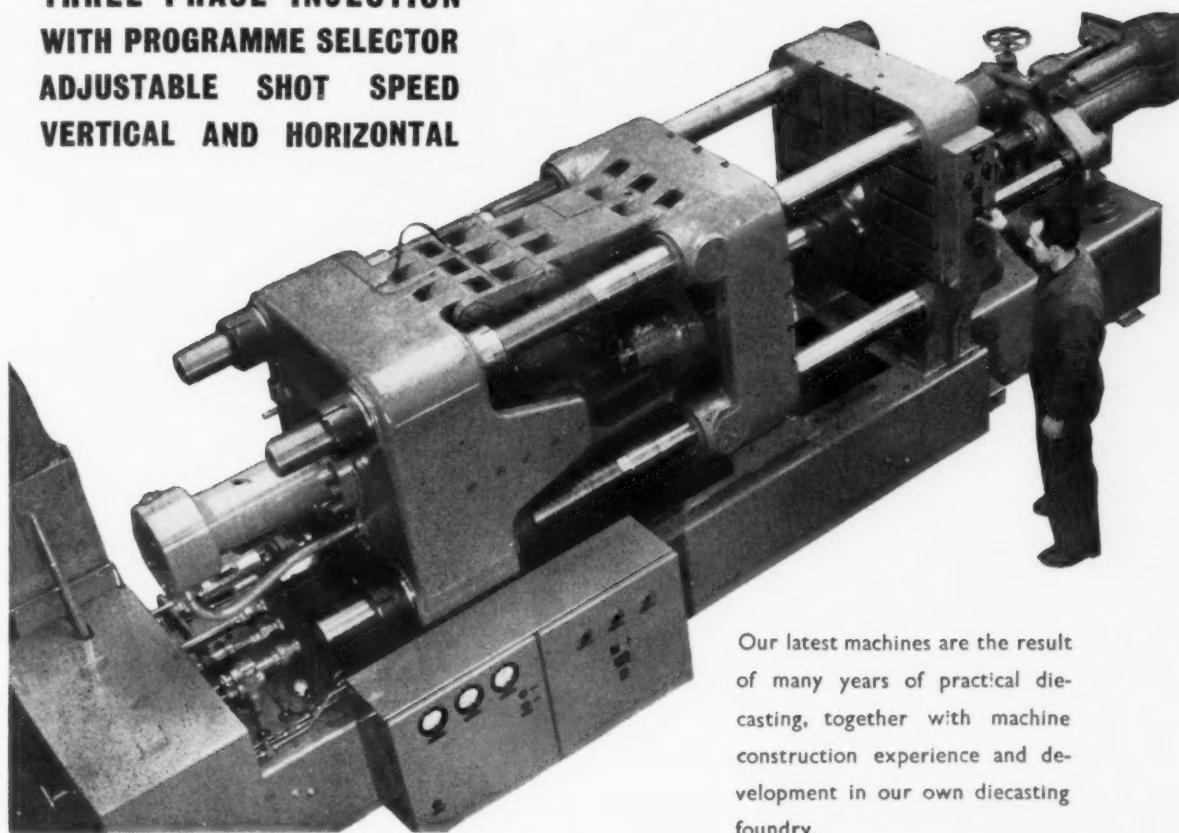
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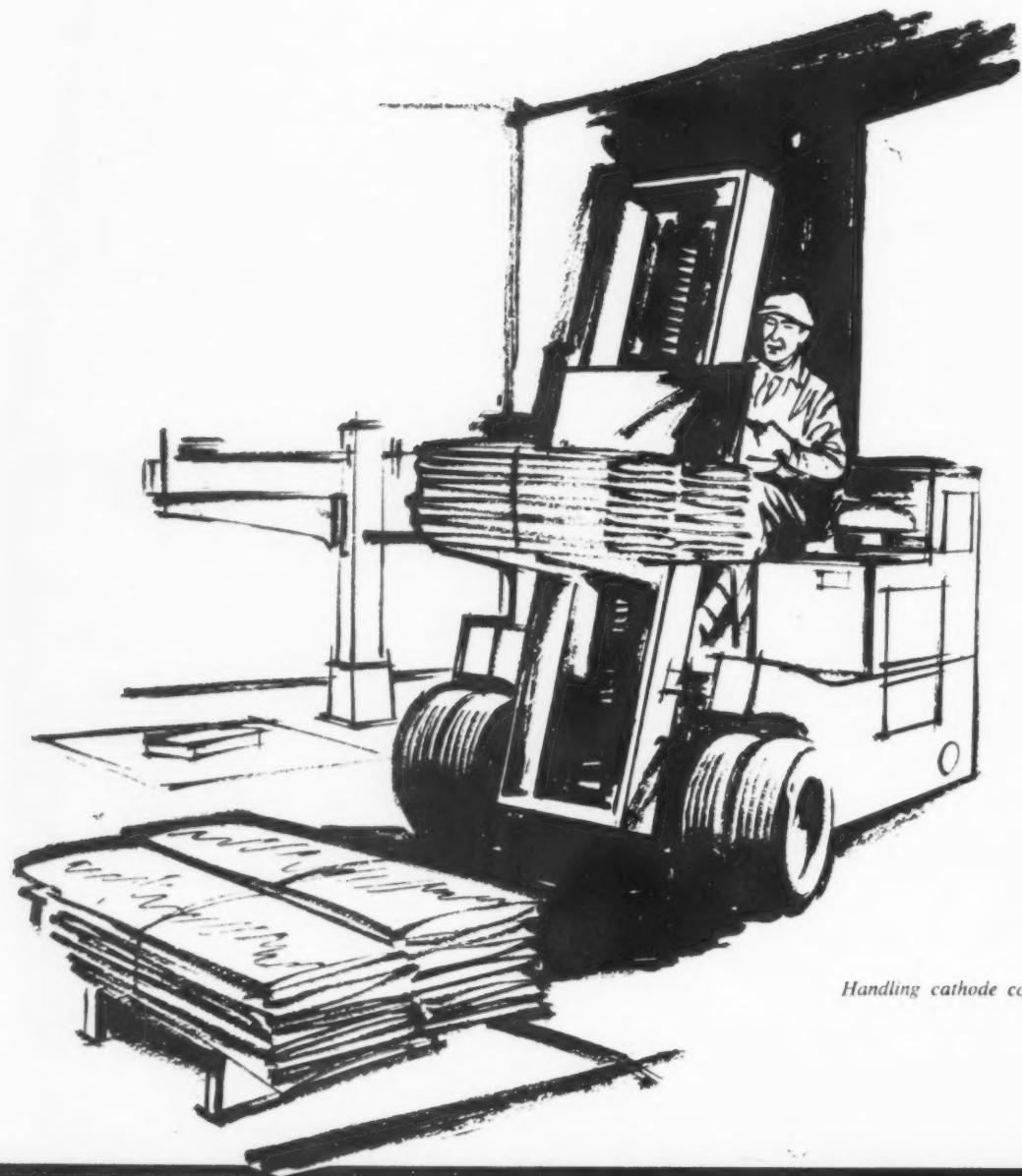


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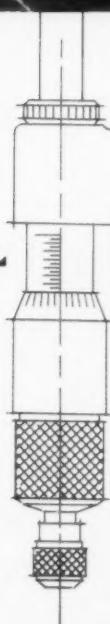
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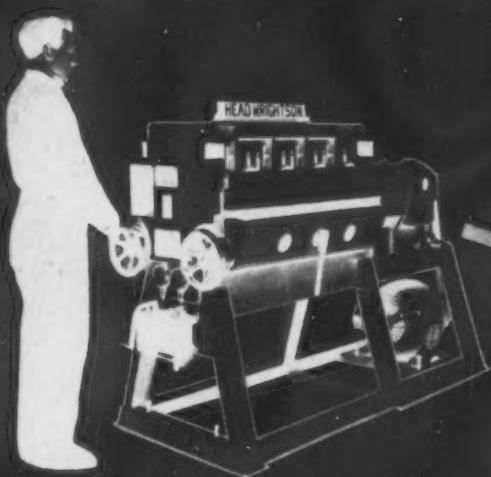
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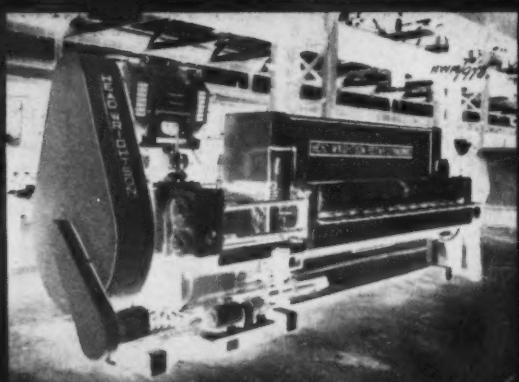
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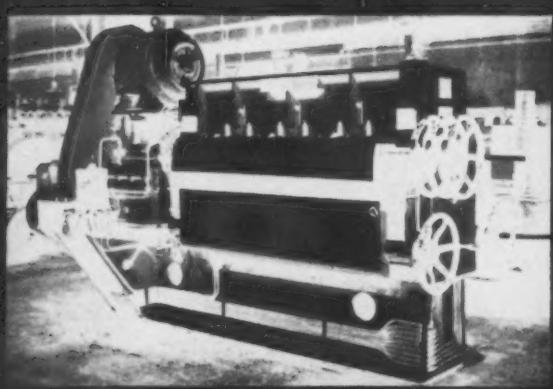
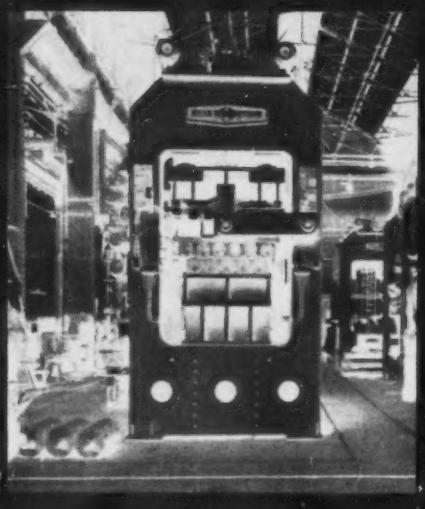


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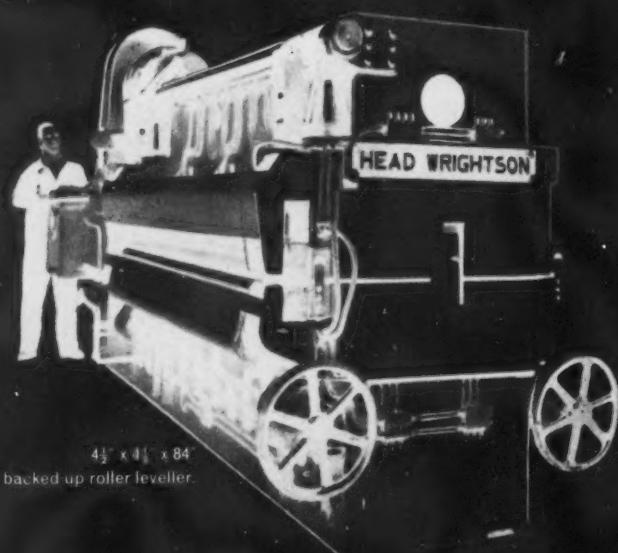


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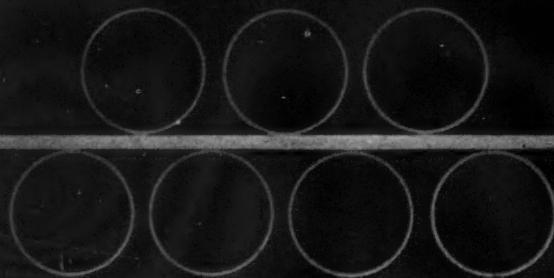
$14'' \times 12'' \times 54''$  Pressure regulating roller leveller.



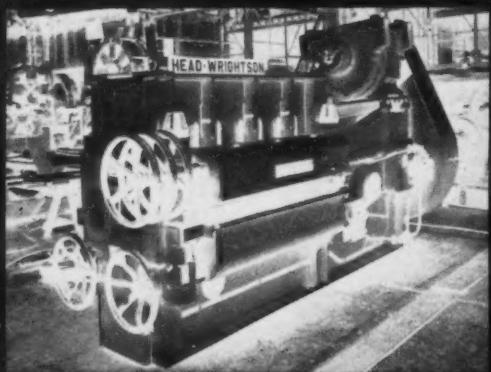
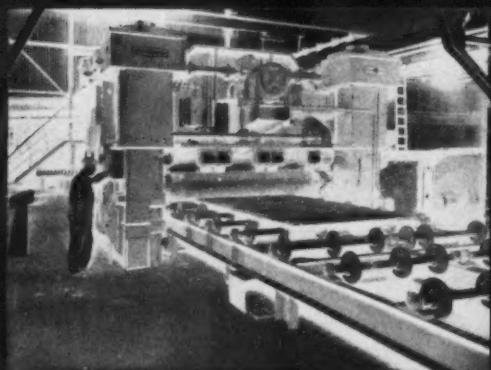
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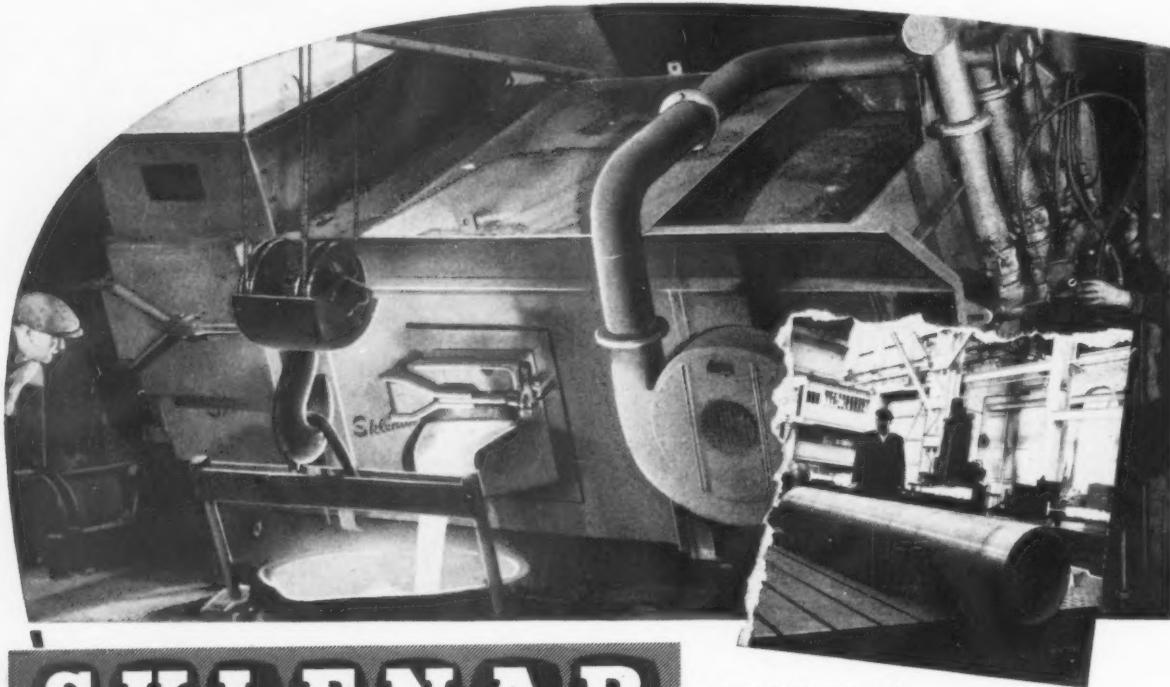
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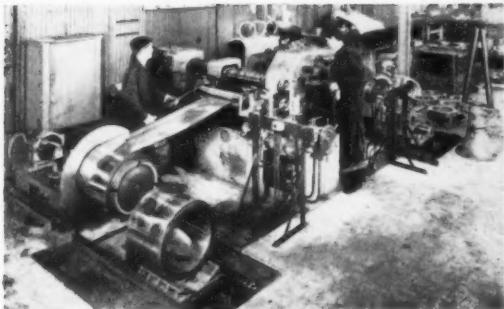
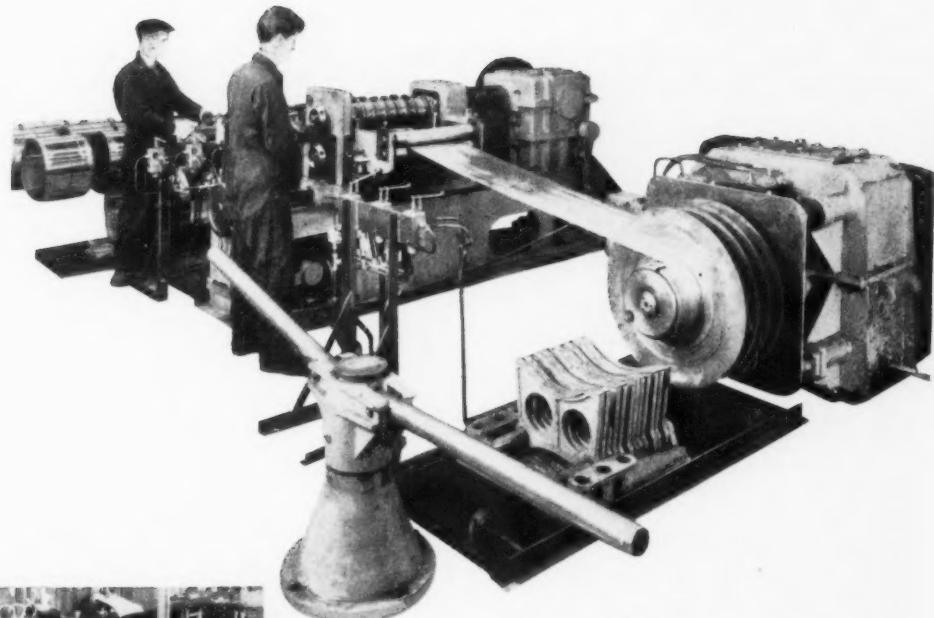
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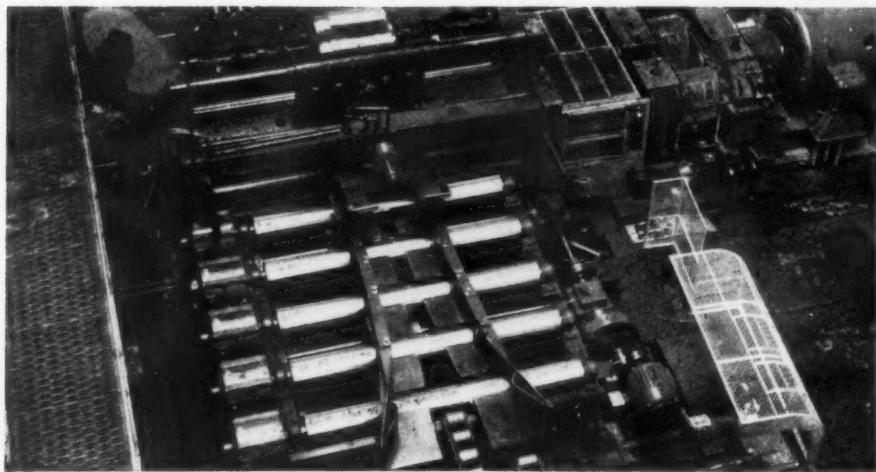
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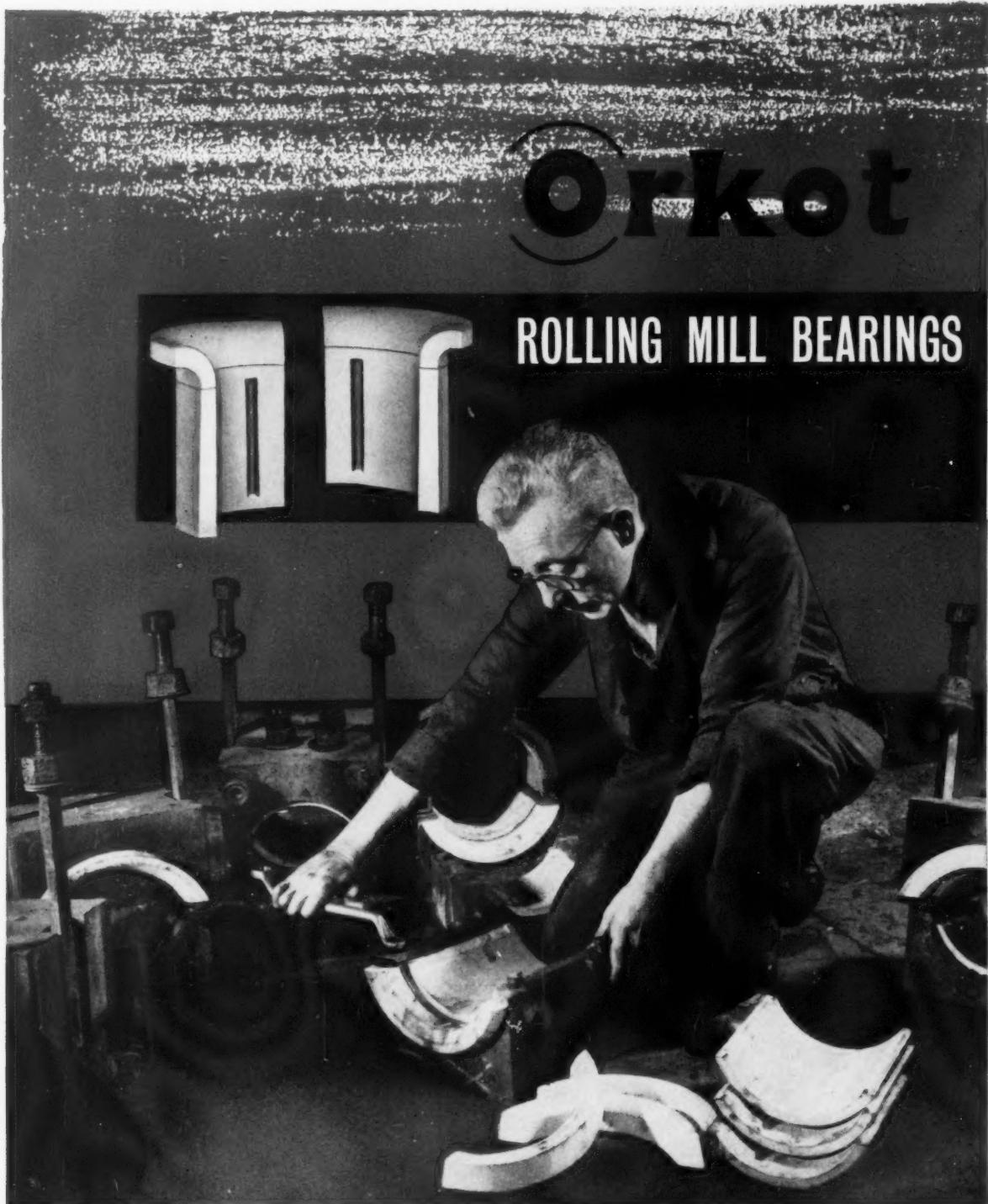
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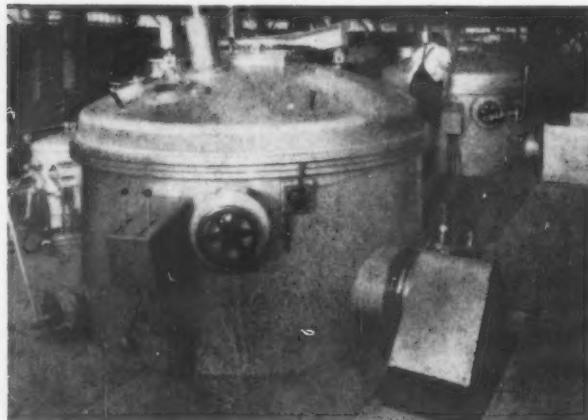
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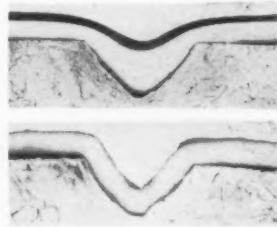
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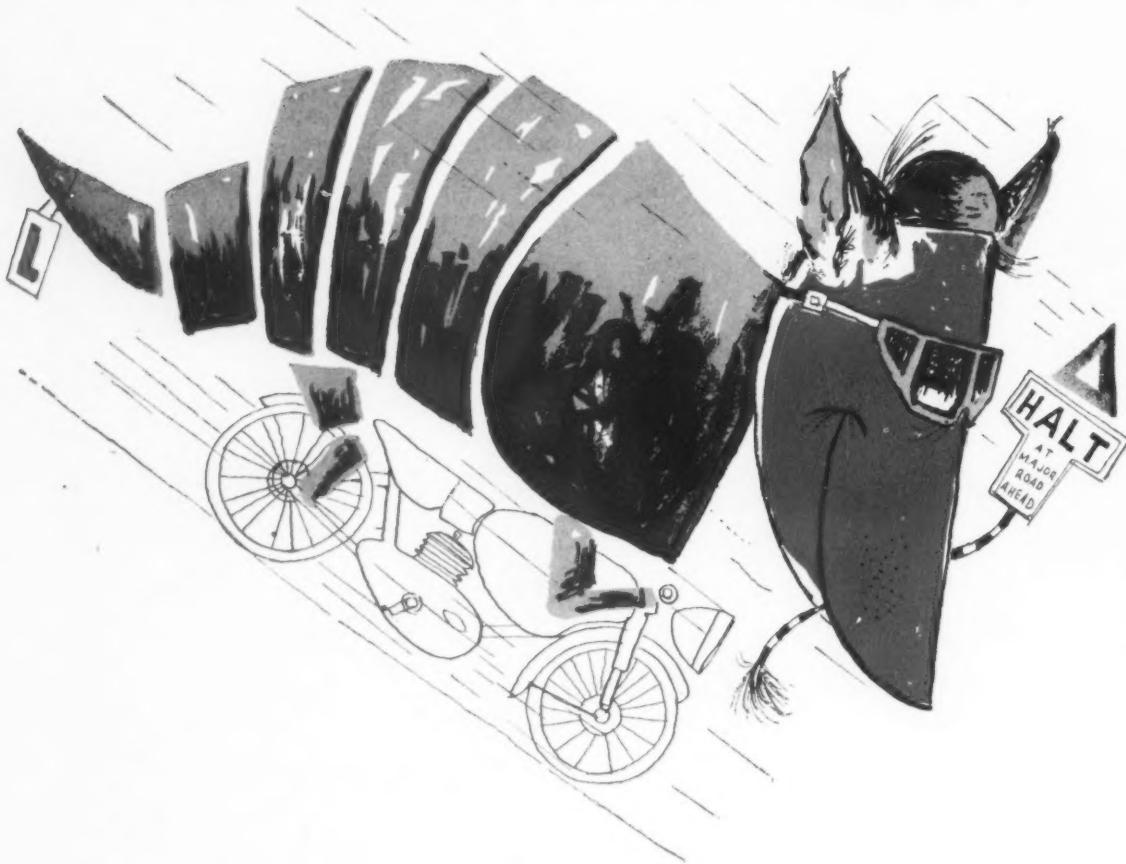
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NUMBER 23

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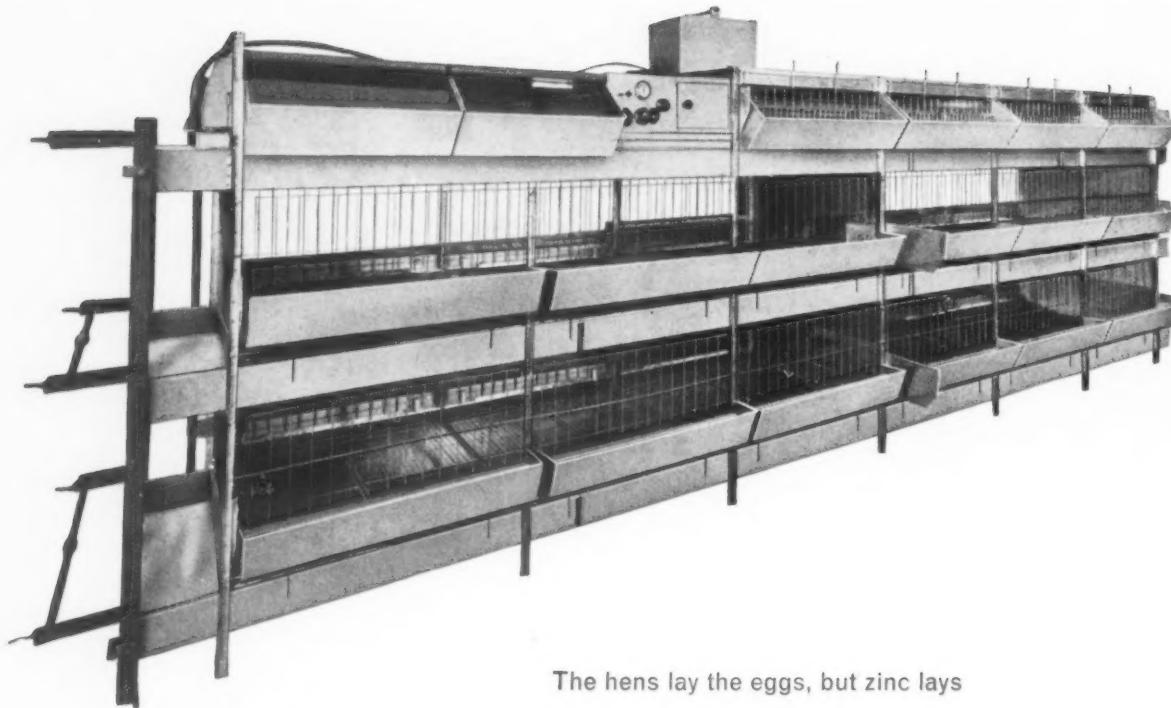
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## Standardization

**A**N efficient economy requires standards, partly in order to achieve savings by the elimination of unnecessary variety and partly in order to reduce waste and danger by preventing the production of sub-standard goods. The recently-held Standards Engineers' Conference was opened by Viscount Hailsham, Lord President of the Council and Minister for Science, who, in the course of his opening address, said that there was a need to revise existing standards as well as to produce new ones. Lord Hailsham went on to say that old standards which have become obsolete are, or can be, as dangerous to industry as no standard at all. It was essential that our standards should be a real incentive to adopt what is best in current engineering practice and not a means of tolerating the mediocre or the worse than mediocre.

A novel suggestion was made at the conference by one speaker, who said that the British Standards Institution could perhaps give a lead by setting up a market research advisory committee to see whether market research could not in some way be utilized in preparing standards. In putting forward this suggestion to the conference, Mr. I. Maclean, of Hawker Siddeley Industries Limited, agreed that market research could be important when standardization was being considered. Examining market research in relation to variety reduction, Mr. Maclean said: "If a potential customer is offered a choice between a standard product which does not exactly match his requirement and a special product at the same price, he will naturally choose the special. The reduction in costs arising from variety reduction must, therefore, be passed on to the customer if the company in question is not to lose all its customers whose requirements are not in line with the standard range of products".

Continuing his theme, Mr. Maclean said: "The extent to which the customer is willing to forego his exact requirements in favour of a lower price is obviously the sort of information that would be of great value in determining whether or not to introduce a range of standard products, and also in determining the sizes within that range". Expressing the view that some performance standards were set at an unnecessarily high level, he instanced transformers, most of which, he said, were only required to operate intermittently for not more than eight to twelve hours daily. But until recently, the standard for rating transformers was on a 24-hour basis. The standard for flame-proof enclosures was much higher in this country than on the Continent. The standard was often unnecessarily high in situations where the risk of explosion was almost negligible. Not all his hearers were in agreement with Mr. Maclean on these latter points. During his speech, however, Mr. Maclean did offer the interesting thought that the big markets of the future were not those of the under-developed countries but those of the already highly developed nations.

In summing up the first day's proceedings of the conference, Sir Stanley Harley suggested that thought could be given to including in the appendices of British Standards guidance for designers on what were believed to be the future trends for the product concerned. He also thought that industry must ask whether its standards were too conservative compared with international practice, to which we must increasingly look if our export trade was to prosper. From this and other points of view, he suggested, market research should be brought into the British Standards Institution's deliberations on standards.

## Out of the MELTING POT

### Possible Promise

**C**ONTINUING search for alloys to be used for precision electrical resistances having a low temperature coefficient of resistance has recently led to the study of ternary copper-base alloys containing 5, 7, 9 and 12 per cent manganese and 1-7 per cent tin. While an immediate rush to make use of such alloys for precision resistances cannot be expected, the preliminary results obtained are undoubtedly interesting and will, it is to be hoped, be supplemented in due course by information regarding such important characteristics as long-term stability, stress sensitivity, manufacturing properties, etc. The alloys were melted in an electric resistance furnace in a graphite crucible provided with a fired-on protective coating of kaolin, alumina and borax. The cast cylindrical billets (90 mm. by 8 mm. diameter) were swaged at 550°-600°C. down to 1.9 mm. diameter rods, which were then drawn hot and cold to 0.7 mm. diameter wire. The most promising properties were obtained with an alloy containing 9 per cent manganese and 4 per cent tin. After vacuum annealing at 570°C., this alloy had a specific electrical resistivity of 0.36 ohm. mm<sup>2</sup>/m., a temperature coefficient (15°-30°C.) of about  $2 \times 10^{-6}$  and zero thermoelectric force against copper over the range of 0° to 100°C. The strength and hardness of the alloy were about the same as those of manganin. The corresponding properties of a quaternary alloy containing 11 per cent manganese, 0.35 per cent tin and 0.3 per cent silicon, balance copper, were 0.42 ohm. mm<sup>2</sup>/m., a zero temperature coefficient and a thermoelectric force of 0.8 microvolts/deg.

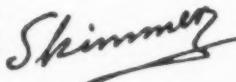
### Ultrasonic Friction

**U**LTRASONIC welding is still in the stage in which almost all contributions regarding its mechanism can be gratefully received with a view to supplementing and ultimately clarifying the collection of suggested mechanisms. Judging by more recent contributions, ultrasonic welding is ultimately most likely to emerge as a form of friction welding. The effects produced by friction on the two surfaces being joined together by an ultrasonic spot weld have been studied by interrupting the welding process after the ultrasonic vibrations had been passed through the spot for periods of time ranging from 0.1 to 1.5 sec. The two surfaces were then separated and examined. The friction between the two surfaces was found to result in the formation of a bright polished zone in the region between the electrodes transmitting the vibrations and applying pressure to the two sheets being joined. The area of this polished zone, from which surface contamination had been removed and over which oxide films had been destroyed by the friction, increased rapidly to a steady value. As the welding process continued, the applied pressure resulted in the formation of a progressive number of areas over which bonding of the two surfaces had occurred. Such bonds, because of their ability to undergo elastic deformation, did not stop the to-and-fro vibrations and the consequent friction between adjoining as-yet-unbonded areas, as a result of which, bonding also occurred in the latter. The progressive bonding of the two surfaces increased the strength of the weld, until a test to destruc-

tion led to the weld being pulled out from one or other of the sheets. Depending on the orientation of the grains on opposite sides of the interface, the bond between two grains may extend along the original interface or, in the case of two similarly oriented grains, a single grain extending across the position of the original interface may be formed. Normal welding times are, of course, too short for any appreciable recrystallization to take place. There was no evidence of melting or even of heating: indeed, microhardness tests on the initially formed polished areas showed that considerable work hardening had occurred. Scratches on the surfaces being joined facilitated bonding.

### Questions on Results

**F**OR strictly utilitarian purposes, the results of a recent investigation of the effects of different oxides ( $ZrO_2$ ,  $TiO_2$ ,  $ThO_2$ ) on the recrystallization behaviour of molybdenum may be adequate. They show that the effects are somewhat different for the different oxides. For zirconium oxide, the temperature of onset of recrystallization (in molybdenum wire drawn 92 per cent at 800°-700°C.) increased with increasing content of zirconium oxide over the range investigated (0.1 to 0.5 per cent), from 1,000° to 1,200°C., which may be compared with the recrystallization temperature of pure molybdenum of 900°C. The grain size after annealing at 1,300°C. for 30 min. likewise decreased continuously with increasing zirconium oxide content. In the case of titanium oxide, the recrystallization temperature rose to a maximum of 1,200°C. at 0.1 per cent, and then decreased as the titanium oxide content was raised to 0.5 per cent. The grain size after annealing (30 min. at 1,300°C.) correspondingly passed through a minimum at 0.1 per cent oxide. The effect of additions of thorium oxide, like that of titanium oxide, was to raise the recrystallization temperature to a maximum of 1,150°C. with 1.0 per cent oxide, after which it dropped as more oxide was added. The minimum grain size after annealing was also obtained by adding 1 per cent of the oxide. The practical value of these results needs no explanation, but explanations of the reasons for them are certainly required. Taking the results at their face value, dislocation theory will find it a little difficult to explain the difference in the effects produced by what, for all its intents and purposes, in all three cases are particles of an inert phase. In searching for an explanation, the theory will no doubt point to the absence of any information on grain sizes, both of the molybdenum powder (which, at any rate, was the same in all cases) and of the oxides which, in all probability, differed very considerably in view of the fact that the zirconium and thorium oxides were introduced as aqueous nitrate solutions, the oxides being formed from the nitrates during the subsequent sintering, whereas the titanium oxide-containing compositions were prepared by mixing an alcoholic slurry of powdered molybdenum and titanium oxide. Different sintering conditions constitute a further source of uncertainty which might provide at least part of the explanation.



# Aluminium Alloys For Deep Drawing

By C. J. SMITH A.I.M.

(Technical Director, Birmetals Ltd.)

(Continued from METAL INDUSTRY, 2 June, 1961)



Deep drawn circular fish kits in Birmabright BB2

[Courtesy Warwick Production Ltd.]

**I**N order to put into perspective the present possibilities in control by simulative testing, it would perhaps be worth first considering briefly the influence of pressing conditions on the behaviour of the metal.

Taking the classical case of the cylindrical cup drawn from a circular blank, it has been established that among the process factors affecting performance of the metal may be listed: (a) ratio of punch and blank diameters; (b) annular clearance between punch and die; (c) punch and die radii; (d) blankholder pressure; (e) speed of drawing; (f) temperature of tools and metal; (g) properties of the lubricant.

A number of studies have been made which attempt to evaluate material behaviour in this "simple" process on the basis of simulative cupping tests, wedge drawing tests and the establishment of relationships between various parameters, which can be measured during tensile, compression and bending tests. It must be regrettably reported, however, that to date, no single test has been found to be completely acceptable in predicting the

behaviour of a metal under variations of the different factors enumerated above.

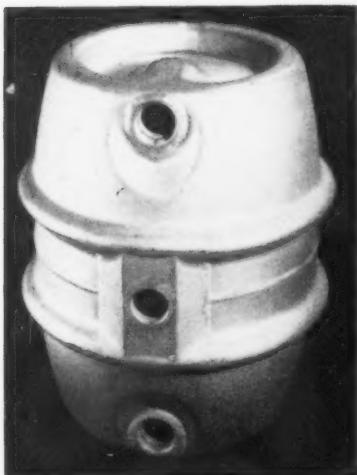
Most work in this field has been done on deep drawing quality steel, where it is generally agreed that the "Swift" cupping test<sup>10</sup> provides a rough sorting test between metals of different deep drawing capacity,<sup>11</sup> but has been reported as failing to fulfil completely the requirements of the press shop in closely discriminating between different steels.<sup>12</sup> Other tests appear to explain particularly the behaviour of the metal during one stage of the pressing operation, e.g., stretching, bending or thickness changes arising under compression and radial flow, yet even so, have a definite place in control of sheet in the rolling mill.

One of the most interesting studies in progress at the present time is that of Chopin<sup>13</sup> in the laboratories of the Centre Technique de l'Aluminium in Paris. A preliminary review of results to date has recently been presented.

The general scope of the work done so far covers examination of six alloys of representative types in different conditions. From these materials, cups

of various dimensions are to be drawn under controlled conditions, and an attempt is to be made to obtain correlation with mechanical property data and behaviour during more simple cupping tests of the Erichsen type. Only one diameter of cup and four thicknesses of metal have yet been examined. Although certain fairly well defined effects of parameters such as metal thickness, choice of lubricant and punch radius already seem to be apparent, the conclusion at this stage is that it has been impossible yet to obtain very satisfactory correlation with the customary properties and tests.

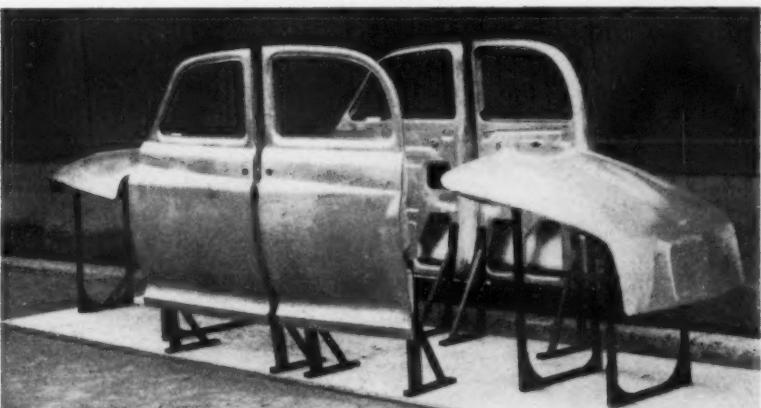
The programme is known to be a most ambitious one, in which it is hoped, from the results of extensive practical cupping tests made on a large variety of diameters and thickness of blank and under many controlled variables of the pressing operation, to be able to plot curves which, by interpolation, should provide useful information to the practical man. Special precautions which are believed to be required to avoid the difficulties which have been encountered with aluminium in some of the reported work on



Left—Welded beer barrel pressings\* in high-purity aluminium, clad with Birmabright BB3 alloy (Hot pressed)

Below—Mock-up of saloon car pressings in Birmabright BB3

[Courtesy Rover Co Ltd.]



"Swift" presses are to receive particular attention.

### Control in Sheet Manufacture

It would obviously be highly desirable to be able to define the drawability of any metal in terms of its fundamental properties such as composition, crystal formation, grain structure, orientation effects, surface finish and similar factors and to relate the conclusions in a scientific way to the geometry of a particular pressing and to criteria of tool design.

Enough has already been said to indicate the limitations of our present knowledge of the inter-relation of these factors. Further, our knowledge is as yet too imperfect even to recognize always which of the various modes of metal forming play the dominant role in the manufacture of a particular component, whereas by so doing, better use might be made of the limited data available.

Nevertheless, certain characteristics of light alloys have come to be recognized as capable of effective control during the sheet manufacturing process.

**Composition.** The general practice in this country<sup>14</sup> is to melt and alloy in large reverberatory furnaces which may be up to 20 tons capacity and may be oil-, coke- or producer gas-fired. Small melts of a few hundred pounds may be made in plumbago crucibles for special purposes. Low frequency induction furnaces, once favoured, have no economic attractions where cheap electricity is not available and give no technical advantages which cannot be obtained in other ways in the larger

units. Whatever the melting method, only charge components of known analysis are utilized, and where scrap is employed it is sometimes pre-ingotted. Direct use of swarf in alloy melting may be avoided in an attempt to reduce oxidation, and special attention has to be given to oil-contaminated sheet cuttings. It is usual practice first to melt the primary ingot components of the charge, following with the various forms of scrap and, later, the alloying elements, reserving until last those which are most volatile, such as zinc and magnesium. This follows practice with other metals.

It is now common practice to sample the bath at this stage, after completing the necessary fluxing and first refining treatments, particularly where a change in alloy or charge components has been made in the melting furnace. The application of the direct reading spectrograph enables analysis to be made rapidly for the major and the very important minor elements,<sup>15</sup> so that necessary adjustments can be made before casting the metal. Although the general composition may be within tolerances at this stage, the melt may not yet be in the best condition for casting by virtue of high gas content<sup>16</sup> or insufficient cleanliness, conditions which may be due either to original charge quality or to melting conditions. It is, therefore, usual to transfer the molten metal in batches of appropriate size to holding furnaces, where it can be suitably treated and brought to casting temperature. In such a furnace, a final fluxing treatment may be given and the metal specially treated with

degassing and grain refining agents.<sup>17</sup> Time may then be allowed for settling out of oxide and nitride contaminants and for equalization of temperature. Where these treatments are prolonged, additional composition checks may be advisable.

No data appear to have been published on the extent to which hydrogen will affect the pressing behaviour of light alloys; theoretical and practical considerations suggest it to have much less effect than in steels. In some alloys, gas-bearing pockets in the cast ingot can prevent the proper welding up of fine porosity during hot rolling, and unless proper precautions are taken at the right stage to apply diffusion heat-treatments, blister may arise during subsequent annealing; moreover, in thick sections, ductility may be adversely affected in the short transverse direction. A secondary effect of high gas content, particularly on the strongest aluminium-magnesium alloys, is the liability to porosity when welded. In this instance, however, initial gas content is not the only criterion since hydrogen may be absorbed due to reaction with water vapour during later heating operations or even during the actual welding process.

Gas contents may be measured before casting either by direct or indirect methods.<sup>18,19,20</sup>

**Rolling Slab Quality..** The ideal characteristics of a high quality rolling slab can be briefly summarized as fine grained structure, freedom from micro-shrinkage, low gas content, little segregation of constituents and negligible directionality of working properties. The extent to which these ideals can be achieved will depend not only upon the alloy composition but also on control of all those factors which lead to uniform cooling conditions during the entire casting operation. The direct chill semi-continuous and con-

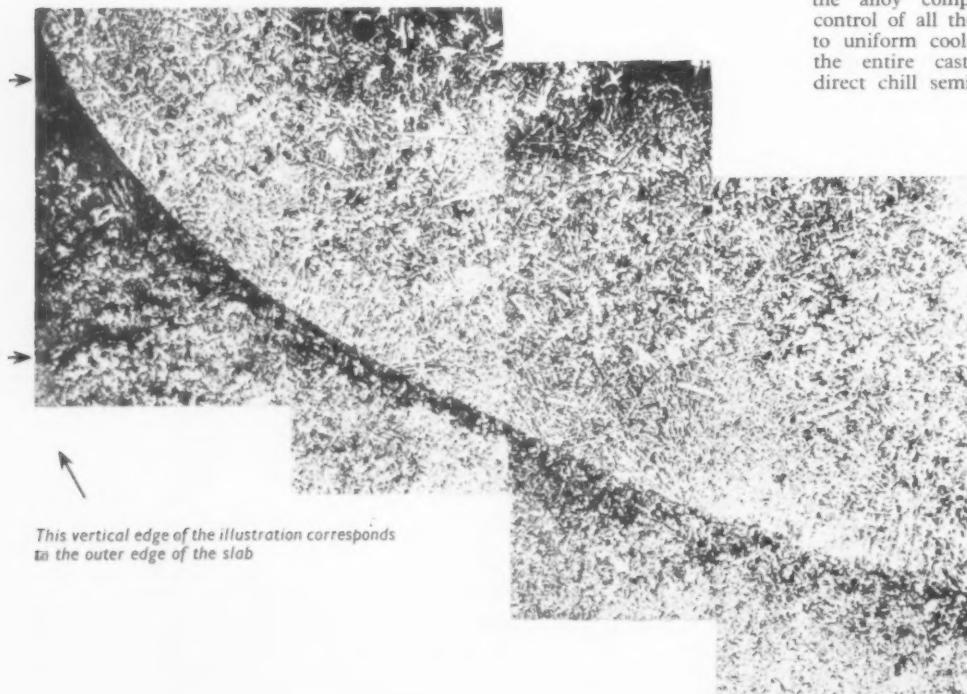


Fig. 5—Composite photograph of macro-structure of segregation on the freezing cone of a slab with interrupted cooling (x 3)

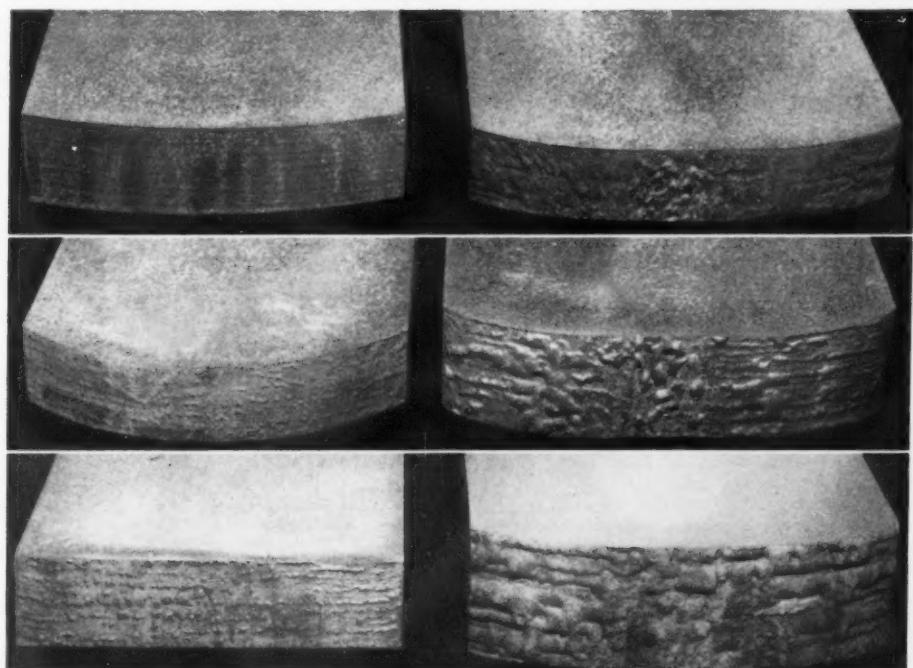


Fig. 7—Transverse macro-sections from aluminium-5 per cent magnesium alloy slabs cast under different conditions

tinuous casting processes, which have already been adequately described elsewhere, call for little comment here.

No single factor can be regarded as more important than any other in affecting the surface and structural quality of the rolling ingot, but two features may be mentioned by way of example. One is the need for careful

Fig. 6—Hot rolled plate showing surface and edge defects of the type shown in Fig. 5 (opposite)



standardization of pouring technique and design of distributors so that metal is fed to the right places in the mould without turbulence and in the needed quantity. Attention to these points not only reduces segregation effects but produces smoother slab surfaces, too, a factor of great importance both to economy and quality.

Another feature, not always appreciated, is the provision of smoothly operating equipment for the mould stool lowering device. Whether hydraulic or mechanical, the ram operating apparatus must be kept under regular surveillance and an adequate scheme of maintenance carried out. It is, in fact, pointless to institute close control of metal temperature, composition, flow rate and cooling equipment if flutter or seizure of the lowering device is permitted to upset the cooling conditions.

The influence of several of the most important factors on ingot quality has been admirably described by Neilson and Kondic.<sup>21</sup>

An example of the type of defect engendered by poor control of casting conditions is given in Fig. 5. The second phase constituents, which have segregated on the interrupted freezing cone extend from the vicinity of the surface well into the body of the slab. The presence of these segregates can give rise to premature edge cracking during hot rolling due to not having adequately diffused in the normal pre-heat cycle, thus producing regions of hot shortness.

The appearance of a hot rolled plate affected by several defects of this type is illustrated in Fig. 6. Even if the actual cracked areas are trimmed off it is impossible to guarantee that detri-

mental effects will not persist and show up in the performance of the finished sheet. In any event, when alloying elements have segregated, there must equally be other regions of the slab having a deficiency of a particular element. Such heterogeneity increases the risk of anisotropic behaviour. For this and other reasons it is common practice for certain alloys to receive prolonged homogenizing treatments of the cast slab before hot rolling.

Transverse macro sections which depict differences in quality in slabs of aluminium-5 per cent magnesium alloy cast under different conditions are shown in Fig. 7. Such macro-sections, taken at regular intervals, provide a check on quality of slabs for rolling and also give a guide as to whether ingot scalping requirements need to be modified.

#### References

- 10 H. W. Swift; *Sheet Metal Ind.*, 1954, **31**, 817.
- 11 R. Pearce; *Sheet Metal Ind.*, 1953, **30**, 1077.
- 12 R. Pearce; *Sheet Metal Ind.*, 1960, **37**, 647.
- 13 R. Chopin; La Determination des Possibilités d'Emboutissage Cylindrique des Alliages Légers.
- 14 R. T. Staples and H. J. Hurst; *J. Inst. Metals*, 1952/53, **81** (7), 377.
- 15 M. Tournaire and M. Renuvard; *Rev. Mét.*, 1959, **56** (5), 435.
- 16 H. Kessler; *Met. Ind.*, 1959, **94**, 163.
- 17 J. E. Dore; American Society for Metals, February, 1959.
- 18 C. E. Ransley, D. E. J. Talbot and H. C. Barlow; *J. Inst. Metals*, 1957-58, **86** (5), 212.
- 19 Y. Dardel; *Met. Ind.*, 1950, **76**, 203.
- 20 F. Rohner; *Schweiz. Archiv.*, 1957 (Aug.), 243.
- 21 P. N. Neilson and V. Kondic; *Met. Ind.*, 1957, **90**, 285.

(To be continued)

# MEN and Metals

Director and general manager of the chemical division of Union Carbide Limited, **Mr. J. F. Wilson** is shortly to take up a new assignment with Union Carbide International Company and will, therefore, be retiring from the board of the former company. **Mr. K. D. Rutter** has been appointed marketing manager, chemicals division, of Union Carbide Limited.

News from the Wellman Smith Owen Engineering Organization is that **Mr. C. D. Wattsworth** has been appointed assistant managing director (technical) and **Mr. D. A. Hume**, assistant managing director (commercial). **Mr. A. T. Easterbrook** has been appointed general manager of the furnace building and contract department in succession to **Mr. G. Talbot**.

Changes in the board of W. Canning and Company Limited were announced last week. **Mr. F. H. Ewens** has relin-



quished the position of joint managing director but will remain as chairman of the board. **Mr. W. H. Griffin** has been appointed deputy chairman and will become sole managing director. **Mr. L. G. Mummiery** relinquishes the office of secretary and is appointed assistant managing director. **Mr. D. Paddon-Smith** has been appointed to the board in place of **Mr. S. S. Dawson**, who has retired, and **Mr. J. M. Stevens** has been appointed secretary to the company.

After a lifetime of service in the steel industry, **Mr. David William Hammond**, B.Sc., F.R.I.C., F.I.M., has retired as a director of Jessop-Saville Limited.

The Minister of Power has re-appointed the following members of the Iron and Steel Board: **Sir Cyril Musgrave**, K.C.B. (chairman); **Sir Lincoln Evans**, C.B.E. (deputy chairman); **Mr. A. G. Stewart** (part-time member). The Minister has also appointed **Mr. N. C. Macdiarmid** as a part-time member in place of **Mr. Arnold E. Pearce**.

A director of Hilger and Watts Limited since 1951, and general manager since 1954, **Mr. A. H. Campbell** has now been appointed joint managing director with **Mr. G. A. Whipple**.

Having joined the research laboratories of The General Electric Co. Ltd. in 1935, **Mr. L. A. Thomas**, B.Sc., F.Inst.P., A.M.I.E.E., has been appointed chief physicist at the Hirst Research Centre of the company at Wembley. Mr. Thomas was appointed head of the materials and components division in 1960, and will retain his responsibilities in this field of the work of the Centre.

It was announced in London at the end of last week that **Mr. James D. Wolff** had resigned as chairman of the board of the Metal Market and Exchange Company Limited. Mr. Wolff had held this position since 1946 and in addition he had served continuously on the committee of the London Metal Exchange from 1928 to 1950. He is succeeded as chairman of the board by **Brigadier H. P. Crossland**, C.B., C.B.E., M.C., T.D., D.L.

Formerly commercial director of Perry Barr Metal Company Limited, **Mr. W. H. Batchelor** has been appointed to the board of Dartmouth Auto Castings Limited as commercial director.

The appointment has been announced of **Mr. R. P. Mackay** to be superintendent, steel plants, of the Steel Division of the Steel Company of Wales Limited. He was previously assistant superintendent.

Appointed manager of the Oilfield Division of U.S. Industries Inc. (Great Britain) Limited, **Mr. C. M. Peters** was previously chief engineer, and, since 1957, Vice-President of Engineering of

the Garrett Oil Tools division of U.S. Industries Inc.

It has been announced by the board of directors of Dialoy Limited that **Mr. F. T. Davies**, A.C.I.S., A.M.I.W.M., has been appointed financial director and secretary.

At present superintendent of research, Steel Division, **Dr. C. S. Ball**, B.Met., Ph.D., F.I.M., has now been



appointed research controller of The Steel Company of Wales. In 1950, Dr. Ball was appointed lecturer in the Department of Industrial Metallurgy of Birmingham University. In 1954 he was appointed assistant chief metallurgist to the Steel Division of the Steel Company of Wales, and in 1957 was appointed chief metallurgist. In July 1960 he became superintendent of research.

Chief mechanical engineer and electrical engineer of the Consolidated Gold Fields of South Africa Limited, **Mr. E. W. F. Clements**, M.I.C.E., M.I.Mech.E., has been appointed a director of Ambuco Limited. **Mr. J. L. Webb** is also taking up the position of contracts manager to Ambuco Limited.

## European Die-casting Production

**A** RECORD total production of pressure die-castings in zinc and aluminium alloys was achieved last year in Western Europe. Production was about 18 per cent above the 1959 level, according to data collected at a meeting of the European Pressure Die Casting Committee in Vienna. Details are given in the accompanying Table. Members

reported that, in spite of the lower rates of car production generally at the beginning of the year, business was now very active again.

The Committee also discussed plans for its Fourth International Pressure Die Casting Conference to be held in Munich from May 6 to May 10, 1963. Details of Conference arrangements will be published later.

EUROPEAN DIE-CASTING PRODUCTION  
(1,000 Metric Tons)

	1959		1960	
	Zinc	Aluminium	Zinc	Aluminium
U.K.	58	23	65	27
France	20	15	22	18 (est.)
W. Germany	25	24	32	31
Italy	7	18	9	21
Others (partly est.)	7	7	8	8
Total	117	87	136	105

## PRINCIPLES, DESIGN AND OPERATION OF B.N.F.M.R.A. INSTRUMENT

# Coulometric Plating Thickness Meter

By R. A. WHITE

(A Communication from the British Non-Ferrous Metals Research Association)

The work described in this Paper was made available to members of the British Non-Ferrous Metals Research Association in a confidential research report, Tech. Memo. 166, issued in January 1960. The author is an investigator in the laboratories of the British Non-Ferrous Metals Research Association, London, N.W.1.

**P**LATING thicknesses can be measured non-destructively by thermoelectric, magnetic or other methods, but the results depend on structure-sensitive properties which, in electroplating, vary from bath to bath, and it is necessary to standardize or check frequently by reference to an exact method such as microsectioning, or stripping and weighing. The latter are slow and inconvenient, and a rapid but still exact method was needed.

The coulometric method, some uses of which have been previously reported<sup>1,2,3</sup>, was found suitable, and an apparatus and procedures suitable for routine use in the plating shop are described here. The method involves the measurement of the total quantity of electricity (current  $\times$  time) which is needed to strip a known area of a deposit anodically. A novel feature of the apparatus is the use of an integrating motor and counter as a coulometer and a simple relay system to stop the coulometer automatically when deplating is complete. A special cell is described, incorporating a moulded plastics cap to seal the cell to the plate and to provide an accurate and reproducibly defined area to be anodically dissolved.

## Principles of the Method

If a plated article is made the anode in an electrolytic cell, the plating will, in general, dissolve when a current is passed, and if conditions are suitably chosen, so that the only reaction occurring at the anode is the electrolytic dissolution of the plating, the amount dissolved is determined strictly by Faraday's laws, i.e. 96,490 coulombs will cause 1 gm. equivalent of the metal to pass into solution. Under these conditions of 100 per cent anodic efficiency it is, therefore, possible by measuring the coulombs (amp  $\times$  sec.) passed to calculate the exact weight of metal transferred to solution, and provided it is possible, for example by following the voltage over the cell, to

recognize the end-point at which the stripping of the coating is complete, it is possible in principle to deduce the weight of coating directly.

To relate this weight of deposit to the thickness, the area to be deplated has to be defined accurately so that the weight per unit area may be calculated and hence the thickness. This has been done in a number of ways<sup>1,2</sup> and generally involves the use of a standard circular hole in a flexible sheet which is pressed, often with a constant loading, on to the plated article by a metal tube which then forms the cathode of the cell.

The area of plate attacked is generally of the order of 0.1-0.2 cm<sup>2</sup> so that an inordinately high current or protracted electrolysis is not necessary, and it should be appreciated that, as the whole accuracy of the thickness determination is dependent on the constancy of this area, great care is necessary in accurately measuring this and ensuring that it is constant from test to test.

In choosing the solution, it must be ensured that no passivation or excessive polarization effects interfere with the dissolution of the coating but that the solution is not so active as to attack the coating chemically. A further requirement is that the stripping of the coating should be completed before any attack occurs on the underlying metal. Ideally, the coating should dissolve at a well-defined constant

anode potential and at the completion of dissolution the potential should rise sharply to a higher value characteristic of some electrode process occurring on the underlying metal, and in practice this is usually quite possible and, as indicated in Fig. 1, the rise in potential may be used to identify the end-point.

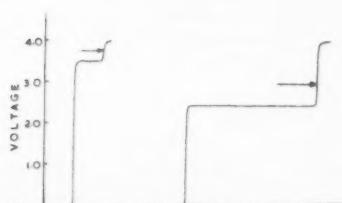
It should be appreciated, however, that some combinations of deposits and basis metal can present considerable difficulty owing to similarity in electrochemical properties, e.g. direct nickel plating on steel,<sup>2</sup> and the difficulties are still greater when the basis metal, or underlying deposit, is much more reactive (electropositive) than the plating to be measured (e.g. direct nickel plating on zinc die-castings).

The necessary conditions, however, have previously been reported for most combinations of deposits and basis metals<sup>2</sup> with the notable exceptions of nickel direct on steel and zinc die-castings without copper undercoats. The instrument described in this report should be able to measure all of these reported combinations. A suitable electrolyte has been found for direct nickel on steel.

## Design and Construction

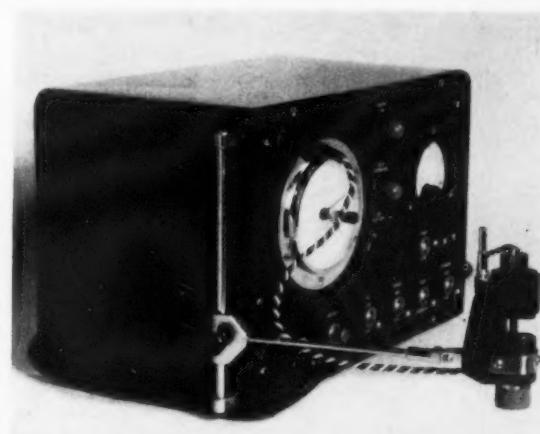
The instrument is built into a standard cabinet, the cell assembly being adjustably mounted on a long arm so that it may be conveniently applied to the plated article (Fig. 2).

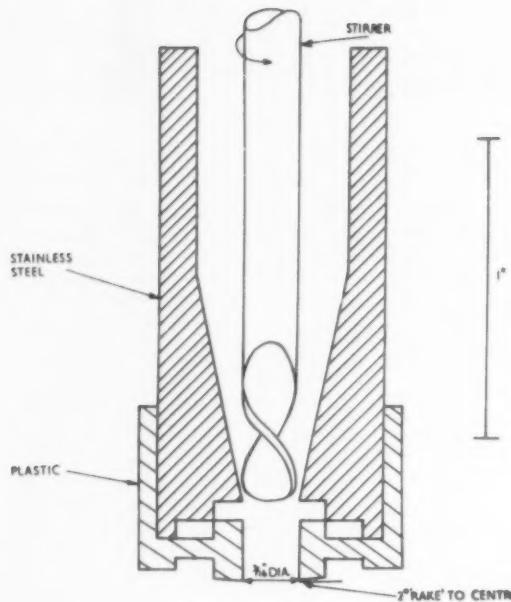
The electrical circuit is, in principle, as shown in Fig. 3. A substantially constant current of 80 mA or 20 mA D.C. is passed through the cell in series with the coulometer M. This integrates



Left: Fig. 1—Voltage/time records during stripping. Left; chromium on nickel (mol H<sub>3</sub>PO<sub>4</sub> solution). Right; nickel on steel (10 mol NH<sub>4</sub>NO<sub>3</sub> solution with thiourea (Arrows indicate end-point voltage)

Right: Fig. 2—The B.N.F. Coulometric Plating Thickness Meter





Left: Fig. 6—Cross section of cell and direction of stirring anti-clockwise  
 Above: Fig. 7—Chromium coating thickness measurements  
 Large figures: strip and weigh. Small figures: coulometric (mean values underlined)

anodically,<sup>4</sup> were discarded for other reasons: strong sulphuric acid because of low anode efficiency, sodium nitrate and chromic acid-boric acid because of the immediate passivation of the nickel.

Strong solutions of ammonium nitrate were found eminently suitable for some bright nickels but with others, and particularly with a dull nickel deposit, immediate passivation resulted. It was found that this difficulty could be overcome by two precautions:

(a) The solution should contain a readily available sulphur compound, the total sulphur being in excess of that required to react with all the dissolved nickel.

(b) The surface of an unprotected dull nickel particularly should be clean before test.

The solution finally adopted for this measurement was 10*M* ammonium nitrate (80 per cent w/v) + *M*/20 thiourea (3.85 per cent w/v), prepared freshly each week. If the nickel deposit is unprotected it is first cleaned with an india-rubber.

*Copper Undercoat on Steel.* During the investigation into the measurement of nickel on steel it was found that ammonium nitrate solution would completely strip a nickel/copper combination, but for quantitative measurement of the copper the presence of ammonium hydroxide was found to be necessary to prevent any copper dissolving as cuprous ions with consequent low results. The following solution was found satisfactory: 10M ammonium nitrate (80 per cent w/v) + M/5 ammonium hydroxide (1 per cent w/v of 0.880 ammonia solution). This solution can be used for the measurement of a copper undercoat on steel after removal of the nickel by stripping in the hydrochloric acid solution.

**Chromium Deposits.** Preliminary work on the determination was done using alkaline solutions—sodium hydroxide,<sup>2</sup> sodium carbonate and trisodium phosphate<sup>1</sup>—to ensure oxidation to the hexavalent state, but difficulty was sometimes experienced with passivation of both the chromium and the nickel undercoat and so attention was given to the possibility of an acid electrolyte.

Phosphoric acid (*M*) was found to give an excellent strip with a sharp voltage change and the use of this electrolyte is recommended.

**General.** A summary is given in Table I of the particular deposits and

## Operation

The working of the instrument is checked with the aid of the dummy load (Fig. 4) and the pointers of the

integrating motor reset to zero. The cell is then placed on the work, firmly pressed down, clamped, and half filled with solution. The stirrer is set in motion and the current value selected. With the backing-off potentiometer set at the appropriate voltage, the determination is started by depressing the "Reset" switch and at the end-point the instrument will switch off. The reading of the integrator is then multiplied by the factor for the deposit under examination to obtain the coating thickness (see "Calibration").

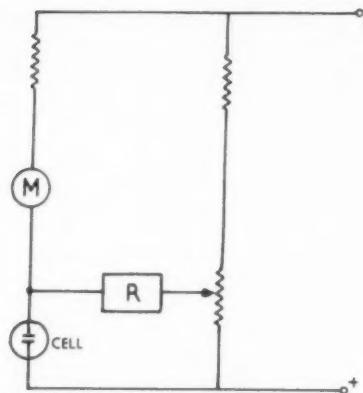
If the running voltage is not known, the determination is started with the backing-off potentiometer set high and the setting is then reduced until the instrument switches off: the potentiometer is then set up 0.25 or 0.5 V and the determination continued as before by depressing the "Reset" switch.

## **Electrolytes**

The electrolytes to be used for the most frequent applications are discussed below.

*Nickel Deposit on Copper Undercoat or on Brass.* No difficulty was experienced with this determination. The solution used is 10 per cent w/v concentrated hydrochloric acid.<sup>4</sup> The end-point is sharp and little or no attack on the basis metal could be seen.

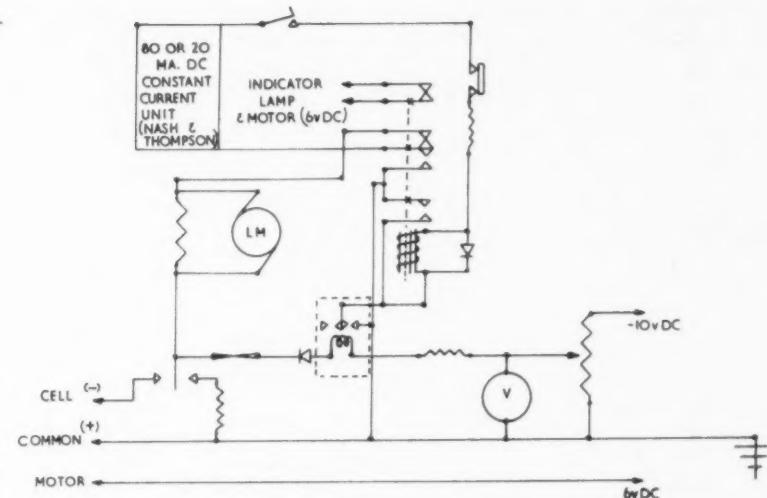
*Nickel Deposits (direct) on Steel.* As mentioned in a preceding section, considerable difficulty was experienced in finding a suitable electrolyte for this purpose owing to the similar properties of these metals. Solutions containing ammonia/ammonium chloride and ammonium phosphate were abandoned because of their aggressiveness to the steel. Some solutions, used in plating practice for stripping nickel deposits



Above: Fig. 3—Principle of circuit

M—Coulometer (dial-reading) R—Relay, switching off cell current when voltage rises

Right: Fig. 4 Electrical arrangement of coulometric meter (production version)



the current passing at any time so that the final reading gives the total quantity of electricity which has been used to strip the deposit, irrespective of any small variations in current. The relay  $R$  can be adjusted with the aid of the voltmeter  $V$ , to switch off at a predetermined cell voltage which is chosen as indicated in Fig. 1 to suit the plating and basis metal under examination. The final reading of the coulometer is multiplied by a constant to give the plating thickness.

The method of obtaining the constants for different coatings is described later under the heading "Calibration".

Several versions have been built, differing in detail, but all incorporating the above features and avoiding valve circuits. The electrical arrangement

of the production version is given in Fig. 4 and full details of an earlier version in Fig. 5. The results quoted in a later section were obtained with the earlier version.

The main points which dictated the final form of the cell were:

(1) The area of plating exposed to anodic action must be definite and reproducible.

(2) The stirring action should be efficient and reproducible to prevent undue polarization of the anode.

(3) The seal to the specimen must be positive and able to conform to moderate curvature of specimen.

The final choice of cell is shown in Fig. 6. The main body of the cell is turned from a  $\frac{1}{2}$  in. diameter stainless steel rod. A seal between the cell and the plated article is conveniently

effected by some form of elastic pad, and in previous instruments this has usually consisted of a rubber washer with a standard-sized hole punched in it, sometimes in conjunction with an external loading device to ensure constant deformation. The accuracy of the determination depends on the accuracy with which this hole can be defined.

In the present design the pad defining the hole is moulded as an integral part of the cap of plasticized P.V.C. fitting over the lower end of the cell, and part of this cap acts as a spring to ensure a constant load. When in use, the cell is pressed firmly down until the outer ring of the cap touches the specimen and the annular ring of plastics between this ring and the inner pad is then under constant strain. As a further

Fig. 5—Circuit diagram

Resistances (all wire wound)— $R_1, R_2, R_3, R_4, R_5, R_{12}, R_{13}, R_{14}, R_{15}, R_{16}, R_{17}, R_{18}, R_{19}, R_{20}, R_{21}, R_{22}, R_{23}, R_{24}, R_{25}, R_{26}, R_{27}, R_{28}, R_{29}, R_{30}, R_{31}, R_{32}, R_{33}, R_{34}, R_{35}, R_{36}, R_{37}, R_{38}, R_{39}, R_{40}, R_{41}, R_{42}, R_{43}, R_{44}, R_{45}, R_{46}, R_{47}, R_{48}, R_{49}, R_{50}, R_{51}, R_{52}, R_{53}, R_{54}, R_{55}, R_{56}, R_{57}, R_{58}, R_{59}, R_{60}, R_{61}, R_{62}, R_{63}, R_{64}, R_{65}, R_{66}, R_{67}, R_{68}, R_{69}, R_{70}, R_{71}, R_{72}, R_{73}, R_{74}, R_{75}, R_{76}, R_{77}, R_{78}, R_{79}, R_{80}, R_{81}, R_{82}, R_{83}, R_{84}, R_{85}, R_{86}, R_{87}, R_{88}, R_{89}, R_{90}, R_{91}, R_{92}, R_{93}, R_{94}, R_{95}, R_{96}, R_{97}, R_{98}, R_{99}, R_{100}, R_{101}, R_{102}, R_{103}, R_{104}, R_{105}, R_{106}, R_{107}, R_{108}, R_{109}, R_{110}, R_{111}, R_{112}, R_{113}, R_{114}, R_{115}, R_{116}, R_{117}, R_{118}, R_{119}, R_{120}, R_{121}, R_{122}, R_{123}, R_{124}, R_{125}, R_{126}, R_{127}, R_{128}, R_{129}, R_{130}, R_{131}, R_{132}, R_{133}, R_{134}, R_{135}, R_{136}, R_{137}, R_{138}, R_{139}, R_{140}, R_{141}, R_{142}, R_{143}, R_{144}, R_{145}, R_{146}, R_{147}, R_{148}, R_{149}, R_{150}, R_{151}, R_{152}, R_{153}, R_{154}, R_{155}, R_{156}, R_{157}, R_{158}, R_{159}, R_{160}, R_{161}, R_{162}, R_{163}, R_{164}, R_{165}, R_{166}, R_{167}, R_{168}, R_{169}, R_{170}, R_{171}, R_{172}, R_{173}, R_{174}, R_{175}, R_{176}, R_{177}, R_{178}, R_{179}, R_{180}, R_{181}, R_{182}, R_{183}, R_{184}, R_{185}, R_{186}, R_{187}, R_{188}, R_{189}, R_{190}, R_{191}, R_{192}, R_{193}, R_{194}, R_{195}, R_{196}, R_{197}, R_{198}, R_{199}, R_{200}, R_{201}, R_{202}, R_{203}, R_{204}, R_{205}, R_{206}, R_{207}, R_{208}, R_{209}, R_{210}, R_{211}, R_{212}, R_{213}, R_{214}, R_{215}, R_{216}, R_{217}, R_{218}, R_{219}, R_{220}, R_{221}, R_{222}, R_{223}, R_{224}, R_{225}, R_{226}, R_{227}, R_{228}, R_{229}, R_{230}, R_{231}, R_{232}, R_{233}, R_{234}, R_{235}, R_{236}, R_{237}, R_{238}, R_{239}, R_{240}, R_{241}, R_{242}, R_{243}, R_{244}, R_{245}, R_{246}, R_{247}, R_{248}, R_{249}, R_{250}, R_{251}, R_{252}, R_{253}, R_{254}, R_{255}, R_{256}, R_{257}, R_{258}, R_{259}, R_{260}, R_{261}, R_{262}, R_{263}, R_{264}, R_{265}, R_{266}, R_{267}, R_{268}, R_{269}, R_{270}, R_{271}, R_{272}, R_{273}, R_{274}, R_{275}, R_{276}, R_{277}, R_{278}, R_{279}, R_{280}, R_{281}, R_{282}, R_{283}, R_{284}, R_{285}, R_{286}, R_{287}, R_{288}, R_{289}, R_{290}, R_{291}, R_{292}, R_{293}, R_{294}, R_{295}, R_{296}, R_{297}, R_{298}, R_{299}, R_{300}, R_{301}, R_{302}, R_{303}, R_{304}, R_{305}, R_{306}, R_{307}, R_{308}, R_{309}, R_{310}, R_{311}, R_{312}, R_{313}, R_{314}, R_{315}, R_{316}, R_{317}, R_{318}, R_{319}, R_{320}, R_{321}, R_{322}, R_{323}, R_{324}, R_{325}, R_{326}, R_{327}, R_{328}, R_{329}, R_{330}, R_{331}, R_{332}, R_{333}, R_{334}, R_{335}, R_{336}, R_{337}, R_{338}, R_{339}, R_{340}, R_{341}, R_{342}, R_{343}, R_{344}, R_{345}, R_{346}, R_{347}, R_{348}, R_{349}, R_{350}, R_{351}, R_{352}, R_{353}, R_{354}, R_{355}, R_{356}, R_{357}, R_{358}, R_{359}, R_{360}, R_{361}, R_{362}, R_{363}, R_{364}, R_{365}, R_{366}, R_{367}, R_{368}, R_{369}, R_{370}, R_{371}, R_{372}, R_{373}, R_{374}, R_{375}, R_{376}, R_{377}, R_{378}, R_{379}, R_{380}, R_{381}, R_{382}, R_{383}, R_{384}, R_{385}, R_{386}, R_{387}, R_{388}, R_{389}, R_{390}, R_{391}, R_{392}, R_{393}, R_{394}, R_{395}, R_{396}, R_{397}, R_{398}, R_{399}, R_{400}, R_{401}, R_{402}, R_{403}, R_{404}, R_{405}, R_{406}, R_{407}, R_{408}, R_{409}, R_{410}, R_{411}, R_{412}, R_{413}, R_{414}, R_{415}, R_{416}, R_{417}, R_{418}, R_{419}, R_{420}, R_{421}, R_{422}, R_{423}, R_{424}, R_{425}, R_{426}, R_{427}, R_{428}, R_{429}, R_{430}, R_{431}, R_{432}, R_{433}, R_{434}, R_{435}, R_{436}, R_{437}, R_{438}, R_{439}, R_{440}, R_{441}, R_{442}, R_{443}, R_{444}, R_{445}, R_{446}, R_{447}, R_{448}, R_{449}, R_{450}, R_{451}, R_{452}, R_{453}, R_{454}, R_{455}, R_{456}, R_{457}, R_{458}, R_{459}, R_{460}, R_{461}, R_{462}, R_{463}, R_{464}, R_{465}, R_{466}, R_{467}, R_{468}, R_{469}, R_{470}, R_{471}, R_{472}, R_{473}, R_{474}, R_{475}, R_{476}, R_{477}, R_{478}, R_{479}, R_{480}, R_{481}, R_{482}, R_{483}, R_{484}, R_{485}, R_{486}, R_{487}, R_{488}, R_{489}, R_{490}, R_{491}, R_{492}, R_{493}, R_{494}, R_{495}, R_{496}, R_{497}, R_{498}, R_{499}, R_{500}, R_{501}, R_{502}, R_{503}, R_{504}, R_{505}, R_{506}, R_{507}, R_{508}, R_{509}, R_{510}, R_{511}, R_{512}, R_{513}, R_{514}, R_{515}, R_{516}, R_{517}, R_{518}, R_{519}, R_{520}, R_{521}, R_{522}, R_{523}, R_{524}, R_{525}, R_{526}, R_{527}, R_{528}, R_{529}, R_{530}, R_{531}, R_{532}, R_{533}, R_{534}, R_{535}, R_{536}, R_{537}, R_{538}, R_{539}, R_{540}, R_{541}, R_{542}, R_{543}, R_{544}, R_{545}, R_{546}, R_{547}, R_{548}, R_{549}, R_{550}, R_{551}, R_{552}, R_{553}, R_{554}, R_{555}, R_{556}, R_{557}, R_{558}, R_{559}, R_{560}, R_{561}, R_{562}, R_{563}, R_{564}, R_{565}, R_{566}, R_{567}, R_{568}, R_{569}, R_{570}, R_{571}, R_{572}, R_{573}, R_{574}, R_{575}, R_{576}, R_{577}, R_{578}, R_{579}, R_{580}, R_{581}, R_{582}, R_{583}, R_{584}, R_{585}, R_{586}, R_{587}, R_{588}, R_{589}, R_{590}, R_{591}, R_{592}, R_{593}, R_{594}, R_{595}, R_{596}, R_{597}, R_{598}, R_{599}, R_{600}, R_{601}, R_{602}, R_{603}, R_{604}, R_{605}, R_{606}, R_{607}, R_{608}, R_{609}, R_{610}, R_{611}, R_{612}, R_{613}, R_{614}, R_{615}, R_{616}, R_{617}, R_{618}, R_{619}, R_{620}, R_{621}, R_{622}, R_{623}, R_{624}, R_{625}, R_{626}, R_{627}, R_{628}, R_{629}, R_{630}, R_{631}, R_{632}, R_{633}, R_{634}, R_{635}, R_{636}, R_{637}, R_{638}, R_{639}, R_{640}, R_{641}, R_{642}, R_{643}, R_{644}, R_{645}, R_{646}, R_{647}, R_{648}, R_{649}, R_{650}, R_{651}, R_{652}, R_{653}, R_{654}, R_{655}, R_{656}, R_{657}, R_{658}, R_{659}, R_{660}, R_{661}, R_{662}, R_{663}, R_{664}, R_{665}, R_{666}, R_{667}, R_{668}, R_{669}, R_{670}, R_{671}, R_{672}, R_{673}, R_{674}, R_{675}, R_{676}, R_{677}, R_{678}, R_{679}, R_{680}, 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R_{80548}, R_{80549}, R_{80550}, R_{80551}, R_{80552}, R_{80553}, R_{80554}, R_{80555}, R_{80556}, R_{80557}, R_{80558}, R_{80559}, R_{80560}, R_{80561}, R_{80562}, R_{80563}, R_{80564}, R_{80565}, R_{80566}, R_{80567}, R_{80568}, R_{80569}, R_{80570}, R_{80571}, R_{80572}, R_{80573}, R_{80574}, R_{80575}, R_{80576}, R_{80577}, R_{80578}, R_{80579}, R_{80580}, R_{80581}, R_{80582}, R_{80583}, R_{80584}, R_{80585}, R_{80586}, R_{80587}, R_{80588}, R_{80589}, R_{80590}, R_{80591}, R_{80592}, R_{80593}, R_{80594}, R_{80595}, R_{80596}, R_{80597}, R_{80598}, R_{80599}, R_{80600}, R_{80601}, R_{80602}, R_{80603}, R_{80604}, R_{80605}, R_{80606}, R_{80607}, R_{80608}, R_{80609}, R_{80610}, R_{80611}, R_{80612}, R_{80613}, R_{80614}, R_{80615}, R_{80616}, R_{80617}, R_{80618}, R_{80619}, R_{80620}, R_{80621}, R_{80622}, R_{80623}, R_{80624}, R_{80625}, R_{80626}, R_{80627}, R_{80628}, R_{80629}, R_{80630}, R_{80631}, R_{80632}, R_{80633}, R_{80634}, R_{80635}, R_{80636}, R_{80637}, R_{80638}, R_{80639}, R_{80640}, R_{80641}, R_{80642}, R_{80643}, R_{80644}, R_{80645}, R_{80646}, R_{80647}, R_{80648}, R_{80649}, R_{80650}, R_{80651}, R_{80652}, R_{80653}, R_{80654}, R_{80655}, R_{80656}, R_{80657}, R_{80658}, R_{80659}, R_{80660}, R_{80661}, R_{80662}, R_{80663}, R_{80664}, R_{80665}, R_{80666}, R_{80667}, R_{80668}, R_{80669}, R_{80670}, R_{80671}, R_{80672}, R_{80673}, R_{80674}, R_{80675}, R_{80676}, R_{80677}, R_{80678}, R_{80679}, R_{80680}, R_{80681}, R_{80682}, R_{80683}, R_{80684}, R_{80685}, R_{80686}, R_{80687}, R_{80688}, R_{80689}, R_{80690}, R_{80691}, R_{80692}, R_{80693}, R_{80694}, R_{80695}, R_{80696}, R_{80697}, R_{80698}, R_{80699}, R_{80700}, R_{80701}, R_{80702}, R_{80703}, R_{80704}, R_{80705}, R_{80706}, R_{80707}, R_{80708}, R_{80709}, R_{80710}, R_{80711}, R_{80712}, R_{80713}, R_{80714}, R_{80715}, R_{80716}, R_{80$

TABLE I—DEPOSITS AND BASIS METALS STUDIED

Coating	Underlying Metal	Solution	mA Current Range	Author and Reference
Cadmium Copper	Steel	10 per cent w/v KCN	—	Francis <sup>2</sup>
	"	10 per cent w/v KCN	—	<i>ibid</i>
	"	10 M NH <sub>4</sub> NO <sub>3</sub> 1 M NH <sub>4</sub> OH	20 or 80	B.N.F.M.R.A.
Chromium	Nickel	(N.Na <sub>2</sub> PO <sub>4</sub> (N.Na <sub>2</sub> SO <sub>4</sub>	—	Anderson and Manual <sup>1</sup>
	"	10 per cent NaOH	—	Francis <sup>2</sup>
	"	M.H <sub>2</sub> PO <sub>4</sub>	20	Waite <sup>3</sup> B.N.F.M.R.A.
Nickel	Copper	10 per cent v/v HCl (conc)	80	B.N.F.M.R.A.
	Steel	(10 M NH <sub>4</sub> NO <sub>3</sub> 1 M 20 CS(NH <sub>2</sub> ) <sub>2</sub>	80	B.N.F.M.R.A.
Lead	Steel	10 per cent NaOH	—	Francis <sup>2</sup>
Tin	"	10 per cent NaOH	—	<i>ibid</i>
Zinc	"	10 per cent NaOH	—	<i>ibid</i>
Silver	"	10 per cent KCN	—	<i>ibid</i>
Gold	"	10 per cent KCN	—	<i>ibid</i>

basis metals studied with this instrument and by other workers together with instrument conditions necessary where they are known.

#### Chromium and Nickel Check

Three specimens of nickel-plated brass were chromium plated to represent a thin, medium and thick finish. From each a centrepiece 2 in. by 4 in. was cut out and these further cut into 1 in. squares, as shown in Fig. 7. Alternate pieces were then used to determine the chromium thickness by

the "strip and weigh" technique and the coulometric procedure.

In Fig. 7, the large single results in each square represent the "strip and weigh" figure and the smaller figures in the corresponding square the coulometric, with the dots to represent the position of the test. The underlined figure is the mean of the coulometric results obtained. When account is taken of the local variation in plating thickness, agreement is good.

For the purpose of testing nickel deposits nickel-plated steel specimens

TABLE II—COMPARISON OF THE MICRO-SECTIONING AND COULOMETRIC METHODS

Nickel Thickness $\times 10^{-3}$ in. Micro-section	Nickel Thickness $\times 10^{-3}$ in. Coulometric	Mean Thickness $\times 10^{-3}$ in. Coulometric	Difference $\times 10^{-3}$ in.
0.25 ± 0.01	0.24 (6) 0.26 (0) 0.25 (8) 0.25 (1) 0.25 (0)	0.25 (3)	0.00
0.47 ± 0.02	0.46 (9) 0.47 (4) 0.46 (7) 0.47 (0)	0.47 (0)	0.00
0.74 ± 0.01	0.72 (2) 0.73 (4) 0.71 (6) 0.71 (6)	0.72 (5)	-0.02
0.92	0.93 (1) 0.91 (5) 0.89 (7) 0.91 (2)	0.91 (4)	-0.01
1.20	1.21 (8) 1.21 (7) 1.22 (5)	1.22 (0)	+0.02
2.10 ± 0.08	2.07 (2) 2.04 (9) 2.07 (0) 2.07 (2)	2.06 (6)	-0.03

Nickel direct on steel with ammonium nitrate electrolyte.

were used, taken from the middle of a large sheet plated to as uniform a thickness as possible, and comparison was made with microscopic measurements on adjacent sections.

The results of the comparison are shown in Table II.

Any error might be expected to be more pronounced when the thickness is large, because not only would any inherent error show itself more but any irregularity in the form of the area attacked, e.g. undercutting, sloping sides, uneven attack, would be aggravated by the greater thickness of the deposit.

In order to obtain some idea of the reproducibility the mean coefficient of variation of the results in Table I was calculated and was found to be 1.2 per cent.

#### Calibration

To calibrate the instrument it is necessary to find the coulomb equivalent of the integrator reading (or some equivalent quantity) and the area of the deposit which is stripped by the cell, and it is necessary to know the equivalent weight of the metal of the coating in the anodic reaction.

To calibrate the integrator, the cell leads are connected to a weighed platinum dish as cathode and a silver disc as anode. This cell is filled with 10 per cent w/v silver nitrate solution, and the instrument is switched on and current passed until a reading of 30,000 has been registered on the integrator (about 45 min.). The platinum dish is then washed, dried and re-weighed. The weight for a reading of 1,000 is calculated.

The area of plating stripped by the cell is found by applying the cell to a piece of nickel-plated copper and measuring the diameters of the etched circles microscopically.

The factor for any particular deposit is then calculated by the following formula:

$$\text{Thickness in } 10^{-3} \text{ in. for 1,000 rev.} =$$

$$\frac{E}{D} \times \frac{1}{A} \times 3.65W$$

where:

E = Equivalent wt. of the particular metal in the anodic reaction

D = Density of deposit (gm/c.c.)

A = Area attacked (in cm<sup>2</sup>)

W = Weight of silver deposited per 1,000 units integrator reading, determined as above.

#### References

- S. Anderson and R. W. Manual; *Trans. Electrochem. Soc.*, 1940, **78**, 373.
- H. T. Francis; *Trans. Electrochem. Soc.*, 1948, **93**, 79.
- C. F. Waite; *Proc. Am. Electroplating Soc.*, 1953, **40**, 113.
- W. Blum and G. B. Hogboom; "Principles of Electroplating and Electro-forming", 3rd Ed., p. 427, McGraw-Hill.

## SUCCESSFUL UNIT AVOIDS PROTRACTED HOLDING AT TEMPERATURE

# Rapid Metal Melting

DURING the early part of 1960, co-operation between Yorkshire Engineering Supplies Ltd. and the North Eastern Gas Board Industrial Development Centre led to the development of a furnace which offers non-ferrous foundries a rapid method of melting by gas.

It was found possible to promote melting at an extremely high rate; for example, 20 lb. of phosphor bronze could be turned into liquid within 2 min. of charging, without any pre-heating of the billets. It must be said that to achieve melting rates as high as this, special attention was paid to the type of flame used and to the temperature of air supplied to the burner equipment. Air pre-heat of some 500°C. gave high flame temperature, encouraging rapid heat exchange. Various methods of disposal of the molten metal were attempted and it was felt that metal disposal at the correct casting temperature was the most difficult problem to solve in instantaneous melting.

Two alternatives appear to be open to the furnace designer with regard to metal handling. The most obvious is to let the metal run into a cooler section of the furnace and collect until a large quantity of metal is available from which baling, tilting or tapping of the furnace can take place. With this method, however, the material is held under thermal conditions for long periods and accompanying deterioration was always noticed. The second method available is the one adopted, i.e. the quick and continuous discharge of the metal from the melting section into a separate handling section from which casting can directly take place at some distance from the furnace. It was around this feature that the furnace was designed.

### Furnace Design

A diagram of the prototype unit is shown in Fig. 1. Its main feature is that the material is placed on the fore-hearth (A) where pre-heating to a dull

red heat takes place whilst the previous charge is being turned into the molten stage on the melting hearth (B). The slope of the hearth shown is determined by experiment, in this case for materials having a casting temperature of 1,150°C. The degree of this slope determines the temperature at which the material will be sufficiently mobile to run to the discharge hole (C) and into the portable handling section, where its temperature can be finally adjusted by the single burner (D).

The burner equipment is so arranged to give extremely even heating over the width and length of the hearth by a large number of burners. These are arranged in two banks (E) and (F). The air-gas mixture is so controlled that reducing or oxidizing conditions can predominate on the top or bottom burners, dependent upon the material being melted. For instance, in the case of phosphor bronze and gunmetals, the burners firing down to the hearth would be run under reducing conditions with the top burners firing across the arch, sufficiently oxidizing to give theoretical combustion at the furnace exit. In this way, protection of the material is provided, preventing oxidation and gas pick-up.

An air pre-heater is arranged around the waste gas flue to provide additional thermal efficiency, raising the temperature of the air for combustion to 350-400°C. In addition, hand shank pre-heating can also be incorporated in

a chest provided in the path of the waste gases.

This unit, designated the "A.C.R.M." furnace, was constructed by the North Eastern Gas Board and was installed in the works of Yorkshire Engineering Supplies Ltd., where the following results were achieved.

### Metal Heats

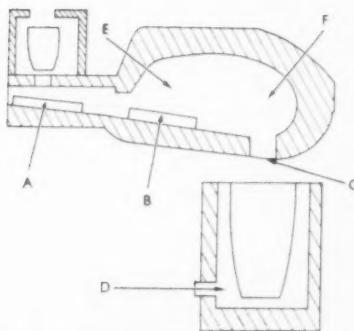
During the melting trials, some 140 metal heats of 100 lb. each were the subject of laboratory observation and examination. The materials employed were chiefly different phosphor bronzes and leaded gunmetals of the type embraced by B.S.1400 and included the popular PBI-C, LG2-C and LG3-C alloys.

The metal heats themselves were made up from either virgin materials, pre-alloyed ingots, part pre-alloyed ingots and part scrap or from part scrap part swarf combinations. In this way it was, therefore, possible to study the melting characteristics of a variety of different types of charges representing a number of different alloy chemical compositions.

The metal heats were timed from charging of materials to completion of melting and this was observed to vary over the range 7-11 min. according to the type of charge.

### Metal Losses

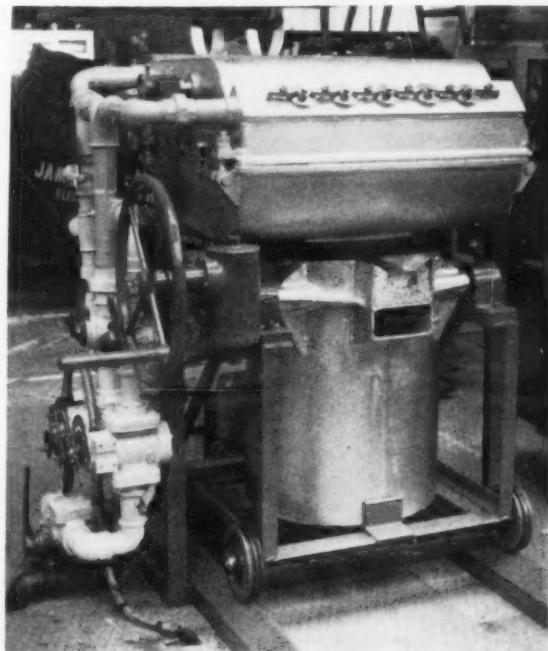
All the metal heats were carefully weighed before charging and again



Left: Fig. 1—Diagram showing arrangement of prototype furnace unit

A—Billet being pre-heated. B—Billet on the melting hearth. C—Discharge hole. D, E, F—Burners

Right: Fig. 2—"A.C.R.M." gas-fired furnace for rapid melting of non-ferrous metals



after melting and casting. The final analysis of the weights recorded showed that the total metal loss for all types of metal heats ranged from 2.3-2.9 per cent, i.e. about half that in normal foundry practice.

The change in composition of the melt was examined. In normal practice gunmetals containing some 5 per cent zinc can often lose about 0.5 per cent of content during the melting cycle. Similarly, phosphor bronzes containing 10 per cent tin and 1.0 per cent phosphorus can lose about 0.25 per cent tin and 0.1 per cent phosphorus. It should be borne in mind, however, that these losses may be variable since they are influenced by furnace thermal

conditions and prevailing atmospheres.

An extensive survey was carried out, using X-ray spectrometric techniques, of the losses incurred by the more volatile metals present in the alloys. Since these analysis techniques permit single element determinations to be completed within 1 to 2 min. of sampling, it was possible to take more than one sample during the melting cycle and compare the results obtained with the chemical composition of the original charge. These tests showed that metal losses were reduced to negligible proportions, being not greater than 0.2 per cent, 0.1 per cent and 0.04 per cent for zinc, tin and phosphorus respectively.

A number of selected samples were examined microscopically after casting them from the "A.C.R.M." furnace and they were found to be normal in every respect and to be entirely free from metallic oxide inclusions.

#### Melting Costs

Whilst these initial melting experiments have been carried out without the use of pre-heated air, the fuel costs (based on gas consumption for 140 metal heats) averaged only 22.3d. per 100 lb. of metal. The introduction of an air pre-heater and the accompanying increase in thermal efficiency will, undoubtedly, reduce melting costs still further.

## A Popular Treatise on Metals

By M. SCHOFIELD M.A., B.Sc., F.R.I.C.

**J**UST 100 years ago, in the same year that Percy published the first volume of his "Metallurgy", a second book appeared in this field though with a lighter treatment of style. Despite its title of popular appeal, "The Playbook of Metals", by John Henry Pepper contributed considerable material on non-ferrous metals, this despite the author's original aim to review mainly "the Chemistry of the Fifty Metallic Elements". Pepper described himself as One-time Professor at the Royal Polytechnic, London, and certainly seems to have been more of a chemist than metallurgist. Yet, with his "personal narratives of visits to mines", which he added as sub-title to his work published by Routledge, Pepper provided an insight into many aspects of non-ferrous metals after referring us for further chemistry to the works of Ure, Bloxham, Abel and Muspratt.

Early matter on "Coal and Coal Mines" and on the alchemical approach to chemistry and metallurgy need only be mentioned, since even illustrations included were of common furnaces, receivers and other equipment for studying metals in bygone centuries. But then come "The Metals and their Combinations", a major section of the book, which includes a number of titillating points on rare metals, some rather obscure today. Though we know "tantalum" is derived from Tantalus and "niobium" from Niobe, goddess of tears, other examples of 1861 have vanished—examples such as "Pelopium" from Pelops and "Donarium" (signifying "a gift").

It is from such works as Pepper's tome that one traces the rise or decline of rare metals, noting how tungsten, titanium and one or two others were then obdurate, resisting all attempts to make them malleable or ductile. Even the fully-written history of gold might well have a few anecdotes added to it from this peculiar book. There are odd details on iron pyrites or "fool's gold", which had to be looked for by

sprinkling it on a red-hot shovel and noting the tell-tale blue flame of sulphur. Birmingham brass sounds to have been a second source of trouble to emigrants to goldfields, due to "the chicanery of their fellow men" in offering prospectors "gold" nuggets manufactured in "the toy shop of the world". If one suspected Brummagem electro-gilt, brass filings or nuggets "got up to look like gold", then Pepper's three pint bottles of aqua fortis, spirits of salt, and oil of vitriol, should be part of the kit, with a Purple of Cassius test for the genuine metal.

In coming to copper and tin resources of last century, Pepper affords us much absorbing matter with accounts of Britain's mines in 1861. From Cornish copper in veins of "rake", "pipe" and "flat" types, on to Devon Great Consols mine, formerly Huel Maria and richest in Devon with its immense water-power on the Tamar's banks and a great number of water-wheels up-river. There is included "Paris" or Parys mine in Anglesey, that richest source in Europe at one period, which caused Amlwch port to be famous. One highlight in the copper story tells of the failure of the foundry owner who undertook to cast the famous bronze column in the Place Vendôme from cannon captured from the Russian armies, a foundryman who refused the advice of the eminent chemist Darset.

With Cornish tin as the subject of a further chapter, Pepper continues to provide the 1861 position. From the "tin floors" at Botallack Mine at St. Just and Iodes 1,800 ft. deep, one goes on to Henderson's "modern stamping-mill", to other crushing mills and buddles for washing tinstone. Tungsten enters into the treatment, with Oxland of Plymouth often referred to as consultant who anticipated tungsten's importance in metallurgy as well as describing the production of tungstate of soda as mordant and as agent for rendering textiles non-inflammable. There are references to James Webster, of Birmingham, and his tin alloys used

in reflectors, bearing-metals, and as white metal.

A chapter on aluminium is of special interest at a time when Gerhard, at Battersea, was struggling to use sodium to displace the metal from a fused cryolite-salt bath and when the Bell brothers were active up in the north. Gerhard's sodium at a shilling an ounce, in place of Deville's figure of five shillings, was a step nearer to Castner's later classic sodium and aluminium making. Aluminium was then sold in jewellery shops as bracelets and chains in "silver from clay", a description which caused some enthusiast to offer Pepper a large clay farm and £1,000 to work it for aluminium! Pepper was an early recipient of one of Deville's bars of metal sent to be shown at the Royal Institution by Napoleon the Third, sponsor of Deville.

From "silver from clay" to true silver the text continues to absorb the reader. There is a vivid account of the Mexican amalgamation process invented by a miner of Pachuca, with teams of mules stamping around the ore sprinkled with mercury; a second study of Pattinson's process, which doubled the production of silver from lead in Britain. Lead-mining follows, and then antimony, arsenic, bismuth and notes on other metals of less import in the viewpoint of 1861.

## Shim Brazing

**A** SHIM brazing process which uses fibre-metal mats in which thin fibres of metal are interlocked like a felt cloth and infused with brazing metal, has been used for bonding joints in material of higher melting temperature than that of the brazing metal. According to Armour Research Foundation, where the method, reported in *American Metal Market*, was developed, the mats are prepared by suspending short metal fibres in glycerine, and then felting them to produce the porous body.

# Industrial News

## Home and Overseas

### Silicone Products

Some changes and additions to their range of silicone products have been announced by **Imperial Chemical Industries Limited**. Two new methyl phenyl fluids, named DP 175 and DP 190, have been placed on the development range. The presence of phenyl radicles gives these fluids advantage over the standard dimethyl silicone fluids for certain applications. These enhanced qualities include greater heat stability and improved compatibility with other materials.

For lubricating oils, the very special properties of DP 190 give it importance for employment in high temperature oil baths, as a high temperature lubricating oil, and as the basis for high temperature lubricating grease.

M 402, a new silicone emulsion for mould release, is now available in quantity. This product is said to give a more viscous coating to mould surfaces because it is the emulsion of a silicone grease in water. For general mould release applications in the rubber, plastics and metal industries, M 402 can be used in the same way as M 400 and M 401. It is, however, outstanding in applications where a good mould coverage is wanted.

### Metal Finishing

A new strippable material for the walls of paint spray booths has been introduced by the Metal Finishing Division of **Pyrene Company Ltd.** This is "Pultac No. 2", which is described as a tough, easily removable film which acts as a barrier between overspray paint and the booth walls. Particulars of this new material are given in an information bulletin available from the company.

### Joining Forces

It is learned that the **Vitreous Enamellers' Association**, for 25 years the trade association of the industry, has joined forces with the Vitreous Enamel Development Council, the industry's promotional body. Its members, in the association's new role, will form a jobbing, signs and general division of the Council.

This brings the number of the Development Council's divisions up to five, the others being the architectural, hollowware, aluminium and frit, and raw materials, and its membership to over 60 companies.

### Special Lecture Courses

In its programme for the winter term, 1961-62 session, the **Borough Polytechnic**, London, S.E.1, announces a series of special lecture courses on the following subjects: (a) Modern developments in non-destructive testing of metals; (b) Refractories, their manufacture, properties and uses; (c) Recent advances in semiconductor metallurgy; and (d) Corrosion and protection of buried metal. Full details of these lectures, fees and dates, may be obtained from the Principal of the Polytechnic, Borough Road, London, S.E.1.

### Copper-Bearing Steels

A new publication from the **Copper Development Association** deals with the various properties of copper-bearing

steels for structural purposes. Diagrams and photographs are included in this 30-page booklet.

### Rare Earth Metals

In a recent announcement from **Johnson, Matthey and Company Ltd.** they state that they are now able to supply scandium, yttrium, and most of the 14 rare earth metals in sheet form in thicknesses down to 0.001 in. and with a maximum width of 3 in. The sheet is available either cold worked or annealed.

This is the latest development in the company's production of the metals of this group, which have previously been available as ingots and in some cases as wire of diameters down to 0.02 in. Specific enquiries for the metals will be welcomed by the company.

### Change of Name

As from Thursday of last week (June 1) the name of the Drayton Regulator and Instrument Company Limited has been changed to **Drayton Controls Limited**.

### Nickel in s.s. "Canberra"

Just released by the **International Nickel Company (Mond) Limited** is a publication with the above title illustrating the "thousand and one" applications of nickel-containing materials in one specific case history. This publication describes, by text and photographs, some of the interesting new features of the *Canberra*, and shows in this, one of the most modern vessels of today, the vital part which nickel plays in the construction of such a vessel.

### Metallic Corrosion

The fourth item in the series of monographs for teachers has recently been published by the **Royal Institute of Chemistry** under the title of "Principles of Metallic Corrosion", by J. P. Chilton. Like the first three monographs in the series, this publication presents a concise and authoritative account of the subject-matter for the guidance of those who teach the subject at G.C.E. Advanced level and above. Though intended primarily for teachers of chemistry, the monograph will doubtless be of value to a wider readership, including more advanced students of chemistry and metallurgy.

This series, which has received the enthusiastic encouragement of the Science Masters' Association, has been sponsored by the Royal Institute of Chemistry Fund for the Development of Education in Chemistry. Copies of Monograph No. 4 may be obtained from the Royal Institute of Chemistry, price 6s. each.

### Industrial Training

Nine regional committees in England, and committees in Scotland and Wales, have been established by the **Industrial Training Council**. These committees are for the general purpose of keeping under review and, in consultation with appropriate organizations, of encouraging arrangements in their regions for the recruitment and training of young people during the "bulge" years.

These regional committees, which have

been set up following the recently-held I.T.C. regional conferences, are composed of representatives nominated by the British Employers' Confederation, the Trades Union Congress and the nationalized industries, and the secretariat for the committees is being provided by the regional offices of the Ministry of Labour.

### Spiral-Flame Gas Burners

New Eclipse "Star-Sixties" spiral-flame burners are stated to create a flat, spiral flame which hugs the arch and/or walls of heat-treat furnaces, galvanizing tanks, etc. Radiation effect, caused by the flame scrubbing large areas of the furnace wall, increases overall heat transfer rates.

The makers say that work can be located very close to the burner without danger of flame impingement or hot spots. As a result, new furnaces can be smaller, with lower heat loss from wall area. Six sizes of these spiral-flame burners provide capacities from 100,000 to 1,800,000 B.Th.U./hr. Flame diameters range from 13 in. to 60 in. Burners are factory-assembled, tested and shipped complete with high-temperature combustion block. Full details of these are available from Ad. Auriema-Europe S.A., 172A Rue Brogniez, Brussels 7, Belgium.

### Change of Address

It is announced by **Opperman Gears Ltd.** and their associate company, Limitorque Valve Controls Ltd., that they have moved their London office to Dutch House, 307-308 High Holborn, W.C.1, under the continued management of Mr. Bert Smith. The new telephone numbers are Holborn 0603-4.

### Machine Tool Research

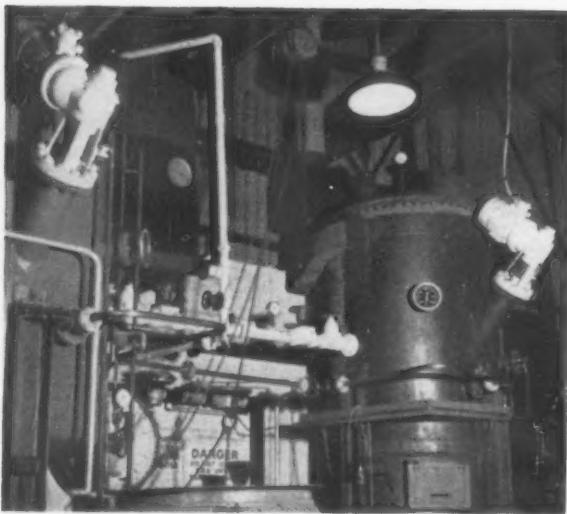
Since the announcement in February this year of the establishment of a machine tool industry research association, considerable progress has been made. The **Machine Tool Industry Research Association** is now a grant-aided research association, and headquarters are being set up in Manchester.

### Sinter Crushers for Rhodesia

News from **The General Electric Company Limited** is that they have recently shipped to Africa two identical 60 in. by 24 in. Pennsylvania single-roll crushers, specially developed for handling hot zinc-lead sinter. These crushers, which were manufactured at the company's Fraser and Chalmers engineering works, were ordered by Lurgi of Frankfurt, and are for installation in two up-draught sinter plants at Broken Hill, Rhodesia.

### Duty Lifted on Aluminium

Recent news from Dublin is to the effect that the Eire Government has made an Order amending the Customs duty on certain aluminium materials to provide for the exemption from duty of aluminium materials used in the manufacture of containers for the transport or storage of beer. The Order came into effect on June 2.



The new D. A. Stuart oil plant at the Wolverhampton works of Amber Oils Ltd.

#### New Wolverhampton Plant

New plant for the manufacture in this country of the products of the D. A. Stuart Co. of Chicago was inaugurated by Col. D. G. N. Lloyd-Lowles, chairman of the **Amber Group of Companies**, on Monday last. These products, originally marketed in this country by Amber Oils Ltd., are now being manufactured and sold here by D. A. Stuart Oil Co. (G.B.) Ltd. (in association with Amber Oils Ltd.) formed here last year for this purpose.

A very wide range of cutting oils and other products will from now on be produced at Wolverhampton, all identical with the American products. The processes followed at the new Wolverhampton plant are the sulphochlorination and sulphurization of fats and hydrocarbons. There are two reaction vessels and the processes are executed by applying heat and pressure under strict control.

These unique cutting oil bases will now be produced entirely here for the British market and will be freely available in the Commonwealth as British exports. The manufacture of these products in Great Britain enables the company to take advantage of the preferential duty available for the distribution throughout the Commonwealth countries. Concentrates are tailor-made to customers' requirements.

#### U.K. Metal Stocks

Copper stocks in London Metal Exchange official warehouses at the end of last week rose 60 tons to 16,527 tons, comprising London 600, Liverpool 13,352, Birmingham 50, Manchester 2,500 and Hull 25 tons.

Tin stocks fell 263 to 8,909 tons, distributed as follows: London 4,204, Liverpool 3,486, and Hull 1,219.

Lead duty-free stocks fell 106 to 7,775 tons, comprising London 7,671, Glasgow four, and Swansea 100. In-bond lead stocks rose 125 tons to 3,843 tons, all stocks held in London.

Zinc duty-free stocks rose 217 tons to 5,238, comprising London 3,830, Liverpool 718, Glasgow 140, and Manchester 550 tons. In-bond zinc stocks rose 477 tons to 2,673 tons, all in London.

#### West German Production

According to official industry figures, West Germany's pig aluminium produc-

tion in April amounted to 14,296 tons (provisional) against 14,424 tons in March. Production of aluminium alloys totalled 9,054 tons (provisional) against 11,076 tons previously.

Refined smelter copper production amounted to 18,940 tons (provisional) against 20,323 tons previously. Refined copper production from refineries and fabricators amounted to 5,869 tons (provisional) against 7,790 tons previously, while copper alloy production totalled 3,624 tons (provisional) against 3,230 tons previously.

Semi-manufactured production of aluminium and aluminium alloys totalled 19,608 tons in April (provisional) against 21,606 tons previously, and of copper and copper alloys 57,573 tons (provisional) against 62,158 tons previously.

#### Mining Developments in Eire

It is reported from Dublin that M. Michel Feron, general manager of the Belgian ore processing company, Metallo Chimique, has flown to Eire to inspect the Can-Erin Copper Mines at Allihies, County Cork, where a large-scale mining project has begun. He said he was interested in the mines as his company planned to take the entire output of copper concentrates and pyrites for processing in Belgium.

For the past few years, Metallo Chimique have been purchasing large quantities of concentrates and pyrites from the copper mines in Avoca, County Wicklow, which were re-opened six years ago by Canadian interests.

#### Golf Tournament

Arrangements have been made for the **Metal Finishing Association** golf competition to be held this year at Kings Norton Golf Club, Birmingham, on Wednesday, June 21.

Two cups are to be competed for in a combined medal and bogey competition over one round of 18 holes, commencing at 3 p.m. Members will be asked to mark their cards with their gross score and the cups will be awarded to the members returning the best net score and the best return against bogey.

A dinner will be held in the evening, at 7 p.m., at which non-golfing members will be welcomed. All members of the association and their friends are invited to play, but members only are eligible to

win either of the cups. Full details of the event may be obtained from the secretary of the association at 27 Frederick Street, Birmingham, 1.

#### New Subsidiary

Three years ago the Diversey Corporation of Chicago extended its interests to this country by the establishment of a wholly-owned British subsidiary manufacturing and marketing a wide range of cleaning and sterilizing products for various industries, including the metal industry.

It is now announced that the corporation has extended their activities by the purchase of Heather Chemical Products Ltd., of Toronto, Canada. This company makes industrial metal cleaners and metal finishing compounds.

#### A New Research Section

In its plant engineering and energy division, the **British Iron and Steel Research Association** has created a new section which will centralize the association's research into control engineering. In view of the advantages to be gained in bringing all the work in the division on control engineering within the province of one section, the electrical engineering section has been replaced by a new control engineering section.

The change of name is a recognition of the gradual change of emphasis in this field of work. The new section will continue the present research into the electrical engineering problems of steelworks with the addition of work on hydraulic control. The association has appointed Mr. J. P. Clyne, M.A., A.M.I.E.E., Grad.I.Mech.E., who has recently joined the association from the Sperry Gyroscope Company Ltd., as head of the new section.

#### An Anniversary

This year sees the 25th anniversary of **L. Light and Company Ltd.**, a concern which was founded in 1936 by Dr. Louis Light and Dr. Henry de Laszlo, since when it has built up an extensive business in manufacturing and supplying the rarer organic chemicals to research workers throughout the world.

Larger offices, stores and laboratories are now under construction, and a new catalogue has just been distributed which contains over 6,000 organic chemicals, biochemicals, pure elements and rare earth. Within just over 100 pages, a short history of the company is given, and the list of contents includes ion-exchange resins, precious metal catalysts, single crystals, pure elements, etc.

#### Aluminium in Tasmania

It was stated on Monday last by the chairman of Comalco Industries Pty. that additional expansion of the capacity of the Bell Bay (Tasmania) aluminium smelter was planned to enable production of 44,000 tons of primary aluminium a year. The additional expansion of Bell Bay's capacity follows discussions with the Premier of Tasmania on the power supplies needed for smelting. A further 35,000 kW will be required.

As a result of these discussions, the Tasmanian Government has undertaken to submit a proposal to Parliament in the forthcoming session to authorize the Hydro-Electric Commission to construct an additional source of electric power on the Derwent River. Parliamentary approval of the expenditure involved

would enable the block of additional power needed for Bell Bay expansion to 44,000 tons to be made available. Power from the Derwent scheme would be available in 1965.

The Bell Bay smelter, which is jointly owned by Cornalco Industries and the Tasmanian Government through Aluminium Production Corporation Ltd. (Apco) is currently being expanded from 12,000 to 28,000 tons per annum. This extra increment of capacity will be fully productive in 1964.

#### Safety Check

A flame safeguard unit that checks its own complete circuit once every second has been announced by **Honeywell Controls Limited**. It is said to be the first continuous-check flame safeguard unit available in this country.

A self-checking circuit disconnects the flame rod and checks all components every second. Such checking has hitherto been incorporated in combustion safeguards during start-up or re-cycling only. The new type, known as the R 4075 Protectoglo, will cause immediate shutdown and sound an alarm if the sensing signal, amplifier or related circuitry fails at any time while burners are operating. The R 4075A Protectoglo is additional to the W 613 type announced earlier this year.

#### A New Club

Stated to be the only one of its kind in this country, the "YZ" Club has just enrolled its first two members. The formation of the club by **The Royal Society for the Prevention of Accidents** was first announced in October 1960. Its object is to encourage employees to take a greater personal interest in the prevention of industrial accidents, and membership is restricted to industrial workers who, by wearing a safety helmet or hard hat whilst at work, have saved themselves from serious head injury from falling materials.

The first two members of the "YZ" Club have already proved the value of wearing safety helmets, as the following accounts show: Mr. D. C. Hicks, a process operator at the British Titan Products Co. Ltd., was struck on the head by a damaged section of wired glass roof light measuring approximately 2 ft. 6 in. by 2 ft., which was dislodged from its frame by vibration. Although the section fell some 30 ft., the fact that Mr. Hicks was wearing a safety helmet undoubtedly saved his head from serious injury. His head was bruised and his left arm lacerated but he was able to continue with his work.

Mr. R. W. Harrison, a tackleman at Dorman, Long (Steel) Ltd., was assisting in the erection of piping underneath a steel plant charging stage. A piece of steel scrap weighing about 28 lb. fell from the furnace pan bench 15 ft. above, and struck his helmet. He was not injured in any way but the helmet was slightly damaged.

Full details concerning membership of the Club may be obtained from the Industrial Safety Division, RoSPA, 75 Victoria Street, London, S.W.1.

#### Belgian Contacts

Arrangements have now been completed by **F. J. Edwards Ltd.** to represent in the country Lefebvre Vaneste and Company, of Gullegem, Belgium, for their complete range of single action, double

action and triple action, double sided hydraulic deep drawing presses, their horizontal hydraulic bending and forming press, generally known as "bulldozer", and open-fronted hydraulic drawing presses. The standard range includes capacities up to 500 tons.

#### Air Compressors

A new range of air compressors featuring compact vertical design and rated for 24-hour heavy duty applications is announced by the air power division of **Joy-Sullivan Limited**. The Joy WG-9 industrial air compressor is a single cylinder, single stage, water-cooled unit, designed for service as a main air supply for all small factories and plants or as an auxiliary supply for larger plants. Available in six cylinder/stroke sizes, giving free air delivered outputs of 75 to 334 ft<sup>3</sup>/min. at working pressures of 15 to 150 lb/in<sup>2</sup>, the largest of these compressors requires a floor space of only 3 ft. by 3 ft. 5 in.

The WG-9 embraces the lower capacity range not already covered by Joy WN series heavy duty stationary compressors. As with the WN series, there is a complementary range of WG-9 compressors specially designed to give completely oil-free air. Designated WGO-9, these units are available for conditions where absolute air purity is critical, such as in the food and chemical industries.

All WG-9s are delivered as an integrated pre-aligned "package" unit, requiring only the preparation of a simple concrete foundation block and connection to the necessary air, power and water lines before being put into service.

#### French-Spanish Mining Deal

According to reports from Paris, the French non-ferrous mining company, Penarroya, has announced that it concluded an agreement with the Spanish National Institute for Industry under which the French firm will participate in the forming of the company Carbonifera del Sur. Penarroya will hand over its concessions and collieries in the Cordoba area, and the Spanish Institute will operate the mines in future.

#### Punching Presses

The Edel range of multiple turret punching presses is now introduced by **F. J. Edwards Limited** with co-ordinating tables for multiple punching, with accuracy and economy, different sized and shaped holes in pre-cut switchboard and chassis blanks. The table carrying the work clamps and material supports is sturdily built and finely balanced. Where necessary, multiple stop rail devices can be fitted for series production. The bottom slides give front-to-back movement, while the top slide, carrying the table, gives left-to-right movement.

Co-ordinating rolling tables are available to suit each size machine and sheet to be processed. Control panels are fitted on the front of the table in the most convenient position for the operator.

#### Joist Automatic Welding

Fillet welding of 8 ft. prefabricated joists for Acrow V form shuttering for concrete buildings (now being used for many of the most important civil engineering contracts in this country) is being carried out at the new Acrow plant in Saffron Walden, Essex, at welding speed of no less than 49 in/min.

Making this possible is the Autopak submerged-arc automatic welding machine by **Rockweld Ltd.**, whose equipment is now in almost continuous service with Acrow.

In the vast Acrow plant, the Autopak set-up, with its single operator and assistant, occupies a negligible floor space of some 200 ft<sup>2</sup>, and uses a 400 V supply at 510 amp. Arc voltage used there is 29-30. The Autopak is suitable for wire sizes from  $\frac{1}{2}$  in. to  $\frac{1}{4}$  in., with a corresponding range of welding currents between 200 and 1,200 amp., at an arc voltage adjustment between 25 and 40.

#### British Oxygen on Show

Repair and maintenance equipment for farmers, agricultural engineers and blacksmiths, and anaesthetic apparatus for veterinary surgeons have been featured on **The British Oxygen Company Ltd.** stands at both the Cheshire and Essex County Agricultural Shows this week. Exhibits included the B.O.C. "Saffire" agricultural outfit for welding, cutting and flame cleaning. The "Saffire" blowpipe, using a variety of interchangeable nozzles, will weld metal up to  $\frac{1}{8}$  in. thick and cut mild steel up to 2 in. thick.

Also shown were two Quasi-Arc electric welding plants—the A.C. Transformer Welding Set (Type ACP 200) and the High Speed D.C. Motor Generator Set (Type MFB 225)—and a selection of manual accessories, argonarc welding torches and sample argonarc welds.

A special display of propane equipment reflected the rapidly expanding use of this fuel in agriculture. The exhibits included equipment for all-purpose space-heating and drying, powerful floodlighting equipment for use where electricity is not available, and a wide range of appliances for metalworking applications in farm and agricultural engineering workshops.

#### Aluminium in Japan

Output of primary aluminium in April, at 12,008 metric tons, increased against March and came close to the all-time peak of 12,153 metric tons produced in October 1960, according to the Light Metals Society. Deliveries of primary aluminium in April renewed an all-time high which was registered in January this year, at 12,657 metric tons. Stocks of primary aluminium at the end of April sharply decreased. No export shipments were reported during April.

#### Annual Conference

Readers are reminded that the annual conference of the Electron Microscopy Group of the Institute of Physics and The Physical Society is to be held from July 10 to 14 next at the University of Nottingham. The conference will be concerned mainly with the physics of the electron microscope and its applications. Registration is necessary for the conference, and applications are available from the offices of the joint societies at 47 Belgrave Square, London, S.W.1.

#### German Metal Consumption

In its annual report, published last week in Düsseldorf, the Non-Ferrous Metal Association showed that West Germany's consumption of non-ferrous metals last year rose by more than 18 per cent over the consumption in the previous year. The consumption of aluminium

(including pig aluminium, aluminium alloys and scrap) rose by 36.6 per cent to 460,429 tons from 337,100 tons previously. That of copper, including scrap and fabricators' consumption, rose by 15.2 per cent to 640,000 tons from 555,400 tons, and that of lead, including alloys and scrap, by 9.9 per cent to 280,600 tons from 255,400 tons.

Zinc consumption, including alloys and scrap, rose by 8.6 per cent to 328,100 tons from 302,000 tons, that of tin by 76.1 per cent to 23,600 tons from 13,400 tons, and that of nickel by 40 per cent to 21,700 tons from 15,500 tons. Production of lead fell to 49,894 tons last year from 52,510 tons previously. That of zinc rose to 86,327 tons from 82,079 tons, and that of copper to 1,777 tons from 1,437 tons.

Stocks of crude non-ferrous metals rose substantially during the year, the report added. Pig aluminium stocks rose by 103 per cent to 55,818 tons, copper stocks by 80 per cent to 53,721 tons, lead stocks by 31 per cent to 45,528 tons, and zinc stocks by 32 per cent to 39,754 tons. Tin stocks fell by 25 per cent to 1,129 tons. Non-ferrous metal exports rose slightly last year, but those of semi-manufactureds fell by 26.4 per cent.

#### Soviet Non-Ferrous Metals

According to the *Economic Gazette*, Moscow, it has been decided to double the lead ore and metal output in the Altai region of East Kazakhstan, the chairman of the Economic Council of this region has stated. The Altai region is one of the areas with the richest deposits of non-ferrous and rare metals deposits in the Soviet Union.

As the extraction rate in East Kazakhstan is already high, amounting to 94.3 per cent for lead, 91 for zinc, 93 for copper, 98 for gold and 99 for silver, it is proposed to step up output without raising costs unduly by a better exploitation of shallow deposits, of which there are dozens in the Altai region, by improving concentration processes and by extracting metals from the slags at the foundries.

This, the *Gazette* states, would yield large additional quantities of zinc, lead and copper, as well as such rare metals as selenium, indium, cadmium and tellurium.

#### Anodized Aluminium

In conjunction with the Department of Metallurgy, University of Nottingham, the **Aluminium Development Association** is organizing a residential conference at the University from September 12 to 14 this year. There will be technical sessions on the afternoon of Tuesday, September 12, and morning and afternoon sessions on the Wednesday. The conference will end officially after breakfast on the Thursday.

The aim of this conference is twofold: (a) to provide an opportunity for anodizers, users of anodized aluminium, and the industry generally, to discuss the latest technical developments; (b) to give research workers in this field an opportunity to discuss the fundamental aspects of their subject.

Fifteen Papers, by British and foreign authors, will be presented. They will be grouped into six sessions under separate headings and, to make the best use of time available, will be printed and distributed well before the conference. In this way the appropriate Papers can be briefly introduced at each session and the rest of the time devoted to discussion and authors' replies.

Accommodation will be in Cripps Hall,

a new University building, and the all-in charge for the conference is 5 gns.; for two nights only, 4 gns.; and for meals only, 3 gn. for each person. Forms of application and full details may be obtained from the offices of the Association at 33 Grosvenor Street, London, W.1.

#### Malayan Tin Shipments

Tin shipments from Penang in May amounted to 6,294 tons, according to the Straits Trading Company. They comprised U.K. options 40, United States 3,099½, the Continent 1,317, Canada 210, Japan 634, the Pacific six, India 551½, South America 210½, Africa 25, Australasia 195 and the Middle East 5½.

Shipments from Singapore in May totalled 498½ tons, comprising United States 115, the Continent 220, the Pacific 12½, India 11, South America 125 and Australasia 15.

#### Protective Treatment

Described as a new protective treatment for aluminium, "Alchromate" has been introduced by **P.M.D. Chemicals Limited**, and they state that this process can be applied with advantage to any of the wide variety of aluminium alloys. In this process, the protective film is ductile and electrically conductive. Since the process is non-electrolytic, the parts can be treated on simple jigs, hooks or baskets. Process time is said to be five minutes maximum.

The surface resistance of the Alchromate film depends upon the type of alloy being treated, contact pressure, surface finish, and depth of film. Naturally, there is an increase in the resistance when compared with a clean unoxidized surface, and users are recommended to send parts to the company for processing, to enable them to ascertain the suitability of the process for specific needs.

The process is stated to be simple and requires no electrical current. The solution is contained in a stainless steel or P.V.C. polythene or neoprene lined mild steel tank. One important application of the process is in the repair of damaged anodized films, and the company says that Alchromate can be applied to these areas locally by swabbing, producing a first class repair.

#### News from Birmingham

Industrial activity is maintained on a high level throughout the metal-using industries in Birmingham and the surrounding area. The recovery in the motor trade referred to at the monthly meeting of the Midland Regional Board for Industry appears to be the biggest factor in bringing down the unemployment rate in the region to 0.9 per cent, as compared with the national average of 1.3 per cent. Maj. C. R. Dibben, the chairman, referred to the general labour shortage, which is still a limiting factor in several industries. Skilled workers are scarce in the engineering trades and in the building industry, where a boom is being enjoyed.

In the iron and steel trade, delivery of material has been speeded up considerably of recent weeks, though there are notable exceptions, such as in sheets. Pressure is strong for sheets for the motor industry. Mills rolling structural steel are fully booked over the current quarter. There are heavy demands for reinforcing rods and bars. Most foundries are well employed on heavy castings. Pig iron deliveries are adequate to cover requirements. The re-rolling mills continue well employed.

## Trade Publications

**Air Control Valves, etc.**—Air Automation, 26 Sharrocks Street, Wolverhampton, Staffs.

This twenty-six page catalogue lists a range of products, the result of a number of years of research into the problem of producing pneumatic equipment which will be completely reliable in use, of moderate price and arranged so that the design engineer's task is made as simple as possible. The catalogue has a thumb index and covers valves, (diaphragm, poppet, and piston), cleaners and lubricators, hose, tubing and blow guns, air line fittings, cylinders, vices, core box and vents. The catalogue is very comprehensive but easily read.

**Rust Removal and Degreasing.**—Basol Ltd., 12 Bolton Street, Piccadilly, London, W.1.

Two little brochures describe the activities of this firm, which produces Basol-Fepar, a rust remover. Also Basol and Eliminax non-caustic degreasers. Technical details, diagrams and photographs are included in both brochures.

**Factory Planning.**—Thos. W. Ward Limited, Albion Works, Sheffield.

Of the many services this company provides, that of its factory planning and installation is the most difficult to describe in a short space. But a new twenty-four page, fully illustrated booklet has now been produced which gives a comprehensive picture of this service. The book is in two parts: the first illustrates the large contracts which have been carried out already for the Atomic Energy Authority, at Dounreay and elsewhere, while part two describes the plant and machinery installation services available. Typical examples are illustrated, showing how Wards assist in dismantling all types of plant and machinery, as well as its transportation and re-erection.

**Chromatographic Analysis.**—W. G. Pye and Company Limited, Granta Works, York Street, Cambridge.

Primarily intended as a comprehensive brochure to describe the new version of the Pye Argon Chromatograph, this brochure contains details of many techniques which have recently been developed in the field of chromatographic analysis. Many diagrams and illustrations are included.

## Company Reports

#### Morgan Crucible

With a 9 per cent final dividend recommended for the year ended April 2 last, Morgan Crucible Company Limited raises its dividend to 14 per cent. Group profits are shown at £2,235,815 (£2,043,417).

#### Firth Cleveland Ltd.

At a board meeting of the company held last week, a resolution was passed recommending a final Ordinary dividend for the year ended December 31, 1960, of 20 per cent, less tax, which, together with the interim dividend of 12 per cent already paid, makes a total of 32 per cent for the year. Group profit after all charges, including taxation, is shown at £1,663,232.

# Metal Market News

## STEADY CONDITIONS ON EXCHANGE — COPPER QUIET BUT FIRMER — BUSY TRADING IN TIN

**S**ENTIMENT both on the Stock Exchange and in Whittington Avenue turned bearish last week, the weakness of sterling not doing anything to help to dissipate the gloom. Apart from copper, steady conditions ruled on the Metal Exchange, but business was reported to be quiet outside. Abroad, holidays in the United States and on the Continent affected trading on the London market, so that one way and another it was not a very cheerful week. In regard to Metal Exchange stocks, there was no change in the tonnage reported for copper, which remained at 16,467 tons. In tin, a small reduction of 18 tons took the stock down to 9,172 tons, while a fall of 180 tons in lead brought the reserve to 11,599 tons. Zinc stocks have been on the increase for some time past, and last week saw them up by 249 tons to 7,217 tons. Apart from Metal Exchange stocks, reserves of non-ferrous metals in the U.K. are adequate and there is no need for undue anxiety should there be a temporary stoppage of supplies. On the market, the happier state of affairs in regard to stocks is reflected in the contango ruling in all the metals. At one time the premium for three months' copper over cash was £3 and at the close of business on Friday afternoon it was only 5s. less. Tin finished with a premium of £6 while forward zinc was 17s. 6d. above cash. In lead, the contango was £1.

In copper, the week began on a nervous note, for nobody knew whether the selling pressure in evidence towards the end of the previous week would be renewed. Apart from this, it soon became known that the situation in Chile had been cleared up, both as to the trouble at El Teniente and also

at the ports. This made for a reactionary trend and it became evident that stale bulls were getting out of their positions. In the States, Comex followed the downward trend developing in London, and the price of copper scrap, on which the custom smelters' quotation mainly depends, progressively fell away. In Whittington Avenue the bottom of the decline came on Thursday afternoon, when cash broke through £240 and was quoted at £239, while three months dropped to £241 15s. 0d. Some recovery, however, was seen on Friday and finally, after a turnover of 12,000 tons, cash closed £3 5s. 0d. down at £240 10s. 0d. and three months £2 5s. 0d. lower at £243 5s. 0d.

Tin closed well below the best at £869 10s. 0d. for cash, after £873, while three months finished the week at £875 10s. 0d. On balance, cash lost £1 and forward gained 10s. The turnover was 825 tons. Lead closed with little change at £65 5s. 0d. for cash and £66 5s. 0d. three months on a turnover of 7,100 tons. At £81 17s. 6d. cash, zinc was 2s. 6d. up, while three months gained 10s. at £82 15s. 0d.

### New York

Following the week-end, copper futures have been easier, in line with the decline in London. Dealings were modest. However, the undertone of physical copper showed no softness. One leading custom smelter who opened books for July said that demand continued good. Leading producers said that demand for July would probably exceed the supply since vacations would reduce the amount of copper available for sale. Scrap copper was steady. Offerings were light. Tin was very steady.

Scattered demand was noted for the nearby positions. Lead was quiet. Zinc was in fair activity. Lead and zinc scrap were moderately active and steady.

In late dealings, tin was firm on solder business in nearbys and good dealer interest in the more distant positions, according to traders. The scrap copper price range narrowed to 26½ to 27 cents per lb.

### Zurich

Lack of uniformity was the most distinctive feature of the Swiss non-ferrous metal market in May. Active dealings were reported from the copper sector, although towards the end of the month buyers showed some reserve in view of higher prices.

Zinc was rather neglected, while buying interest in lead increased towards the end of the month as a result of a decline in prices. The present shortage of tin was reflected in rising demand, due partly also to the replenishment of traders' stocks. Business was lively on the aluminium sector.

### Cuba

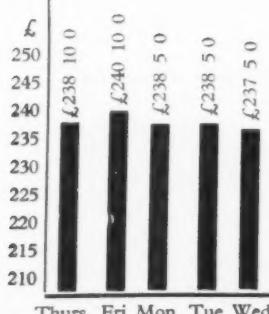
According to reports from Havana, the Soviet Union will give Cuba technical assistance for mining and processing nickel under an agreement signed there last week. The Minister of Industries, Dr. Ernest Guevara, who signed for Cuba, said Cuba will become the world's second largest nickel producer after Canada. Soviet assistance will be worth 100 million pesos, Dr. Guevara said. The agreement will also cover mining and processing of cobalt.

The main centre of nickel production would be at the Nicaro mines in Oriente province. The agreement covered the sending of Soviet technicians to carry out research and survey projects, provision of machinery and mining materials not available in Cuba, and the provision of trained specialists to initiate and maintain technical processes involved in mining.

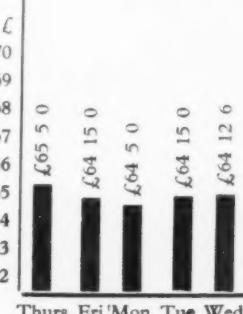
## London Metal Exchange

Thursday 31 May to Wednesday 7 June 1961

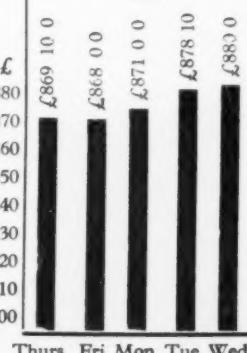
### COPPER



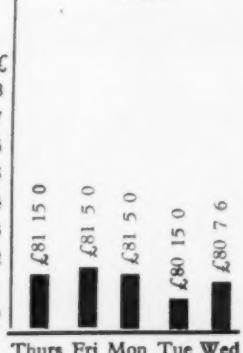
### LEAD



### TIN



### ZINC



# **NON-FERROUS**

# PRIMARY METALS

All prices quoted are those available at 2 p.m. 7 6 61

		£	s.	d.		£	s.	d.		£	s.	d.		
<b>Aluminium Ingots</b>	ton	186	0	0	<b>Copper Sulphate</b>	ton	80	10	0	<b>Palladium</b>	oz.	9	0	0
<b>Antimony 99.6%</b>	"	237	10	0	<b>Germanium</b>	grm.	—			<b>Platinum</b>	"	30	5	0
<b>Antimony Metal 99%</b>	"	230	0	0	<b>Gold</b>	oz.	12	11	3½	<b>Rhodium</b>	"	46	0	0
<b>Antimony Oxide</b>					<b>Indium</b>	"	10	0		<b>Ruthenium</b>	"	16	0	0
Commercial	"	194	10	0	<b>Iridium</b>	"	24	0	0	<b>Selenium</b>	lb.	2	6	6
<b>Antimony White Oxide</b>	"	212	0	0	<b>Lanthanum</b>	grm.	15	0		<b>Silicon 98%</b>	ton	123	0	0
<b>Arsenic</b>	"	400	0	0	<b>Lead English</b>	ton	64	12	6	<b>Silver Spot Bars</b>	oz.	6	7	5
<b>Bismuth 99.95%</b>	lb.	16	0		<b>Magnesium Ingots</b>	lb.				<b>Tellurium Sticks</b>	lb.	2	0	0
<b>Cadmium 99.9%</b>	"	11	0		99.8%	"	2	2½		<b>Tin</b>	ton	880	0	0
<b>Calcium</b>	"	2	0	0	99.9-%	"	2	3		<b>Zinc</b>				
<b>Cerium 99%</b>	"	15	0	0	Notched Bar	"	2	9½		Electrolytic	ton	—		
<b>Chromium</b>	"	6	11		Powder Grade 4	"	5	6		Min 99.99%	"	—		
<b>Cobalt</b>	"	12	0		Alloy Ingot, AZ91X	"	1	11½-2	1½	Virgin Min 98%	"	80	16	10½
<b>Columbite</b> per unit		8	10	0	<b>Manganese Metal</b>	ton	280	0	0	Dust 95.97%	"	125	0	0
<b>Copper H.C. Electro.</b>	ton	237	5	0	<b>Mercury</b>	flask	67	0	0	Dust 98.99%	"	131	0	0
Fire Refined 99.70%	"	236	0	0	<b>Molybdenum</b>	lb.	1	10	0	Granulated 99.9%	"	105	16	10½
Fire Refined 99.50%	"	235	0	0	<b>Nickel</b>	ton	600	0	0	Granulated 99.99%	"	120	6	3
					F. Shot	lb.	5	5						
					F. Ingot	"	5	6						
					<b>Osmium</b>	oz.	20	0	0					
					<b>Osmiridium</b>	"	—							

*\*Duty and Carriage to customers' works for buyers' account.*

## INGOT METALS

All prices quoted are those available at 2 p.m. 7/6/61

## SCRAP METALS

**Merchants' average buying prices delivered, per ton, 6/6/61**

<b>Aluminium</b>	<b>£</b>	<b>Copper</b>	<b>£</b>	<b>Lead</b>	<b>£</b>
New Cuttings .....	135	Wire .....	216	Scrap .....	55
Old Rolled .....	104	Firebox, cut up .....	214		
Segregated Turnings .....	78	Heavy .....	213	<b>Nickel</b>	
		Light .....	209	Cuttings .....	
		Cuttings .....	221	Anodes .....	554
		Turnings .....	193		
		Brazier .....	185	<b>Phosphor Bronze</b>	
<b>Brass</b>				Scrap .....	192
Cuttings .....	168			Turnings .....	187
Rod Ends .....	152				
Heavy Yellow .....	143				
Light .....	138	<b>Gunmetal</b>			
Rolled .....	157	Gear Wheels .....	207	<b>Zinc</b>	
Collected Scrap .....	141	Admiralty .....	207	Remelted .....	75
Turnings .....	145	Commercial .....	192	Cuttings .....	67
		Turnings .....	187	Old Zinc .....	45

# METAL PRICES

## SEMI-FABRICATED PRODUCTS

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products

<b>Aluminium</b>	<b>£ s. d.</b>	<b>Aluminium Alloys—cont.</b>	<b>£ s. d.</b>	<b>Beryllium Copper</b>	<b>£ s. d.</b>
Sheet 10 S.W.G. lb.	2 10 ½	BS1477. HPC15WP.	£ s. d.	Strip .....	lb. 1 4 11
Sheet 18 S.W.G. ,,,	3 0 ½	Plate heat treated ... lb.	3 10 ½	Rod .....	,, 1 1 6
Sheet 24 S.W.G. ,,,	3 3 ½	BS1475. HG19W.		Wire .....	,, 1 4 9
Strip 10 S.W.G. ,,,	2 10 ½	Wire 10 S.W.G. ,,,	4 2	<b>Copper</b>	
Strip 18 S.W.G. ,,,	2 11 ½	BS1471. HT19WP.		Tubes .....	lb. 2 5 ½
Strip 24 S.W.G. ,,,	3 1	Tubes 1 in. o.d.		Sheet .....	ton 275 5 0
Circles 22 S.W.G. ,,,	3 4 ½	16 S.W.G. ....	5 5	Strip .....	,, 275 5 0
Circles 18 S.W.G. ,,,	3 3 ½	BS1476. HE19WP.		H.C. Wire .....	,, 291 15 0
Circles 12 S.W.G. ,,,	3 2 ½	Sections .....	3 4	<b>Cupro Nickel</b>	
Plate as rolled .....	2 10	Split tube		Tubes 70/30 .....	lb. 3 7 ½
Sections .....	3 4	19 S.W.G. (½") .....	4 2	<b>Lead</b>	
Wire 10 S.W.G. ,,,	3 1 ½	20 S.W.G. (¾") .....	3 11	Pipes (London) .....	ton 107 0 0
Tubes 1 in. o.d.		21 S.W.G. (½") .....	4 1	Sheet (London) .....	,, 104 15 0
16 S.W.G. ,,,	4 4	22 S.W.G. (½") .....	4 11	Tellurium Lead .....	,, £6 extra
<b>Aluminium Alloys</b>		<b>Welded tube</b>		<b>Nickel Silver</b>	
BS 1470. HS19W.		14 to 20 S.W.G.		Sheet and Strip 10% .. lb. 3 11 ½	
Sheet 10 S.W.G. ,,,	3 3	(sizes ½" to 1 ½") .....	,, 3 10 ½ to 5 8 ½	Wire 10% .. ,,, 4 4 ½	
Sheet 18 S.W.G. ,,,	3 5 ½	<b>Brass</b>		<b>Phosphor Bronze</b>	
Sheet 24 S.W.G. ,,,	4 1	Tubes .....	lb. 1 11 ½	Wire .....	4 2 ½
Strip 10 S.W.G. ,,,	3 3	Brazed Tubes .....	3 3 ½	<b>Titanium (1,000 lb. lots)</b>	
Strip 18 S.W.G. ,,,	3 4 ½	Drawn Strip Sections .....	3 3 ½	Billet 4 ½" to 18" dia. .. lb. 47/- 48/-	
Strip 24 S.W.G. ,,,	4 0 ½	Sheet .....	ton 206 5 0	Rod 4" to 4" dia. .. ,,, 85/- 53/-	
BS1477. HP30M.		Strip .....	,, 206 5 0	Wire 036"-232" dia. .. ,,, 159/- 99/-	
Plate as rolled .....	3 1	Extruded Bar .....	lb. 2 1	Strip .001" to .048" .. ,,, 350/- 68/-	
BS1470. HC15WP.		Condenser Plate (Yellow Metal) .....	ton 196 0 0	Sheet 8" x 2' 20 gauge .. ,,, 73/-	
Sheet 10 S.W.G. ,,,	4 3	Condenser Plate (Naval Brass) .....	,, 209 0 0	Tube, representative average gauge .. ,,, 198/-	
Sheet 18 S.W.G. ,,,	4 8 ½	Wire .....	lb. 2 9 ½	Extrusions .....	,,, 90/-
Sheet 24 S.W.G. ,,,	5 8 ½			<b>Zinc</b>	
Strip 10 S.W.G. ,,,	4 4			Sheet .....	ton 119 5 0
Strip 18 S.W.G. ,,,	4 8 ½			Strip .....	,,, nom.
Strip 24 S.W.G. ,,,	5 4 ½				

## FOREIGN QUOTATIONS

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

<b>Belgium</b>	fr/kg	£/ton	<b>Italy</b>	lire/kg	£/ton	<b>Japan</b>	Yen per metric ton
Copper: electrolytic	33.75	246 13	Aluminium .....	370	216 1	Scrap	
Tin .....	122.00	891 13	Antimony 99.0 .....	520	303 13	Copper: electrolytic ..	308,000
<b>Canada</b>	c lb	£/ton	Copper: wire bars 99.9 .....	470	347 6	Copper wire No. 1 .....	276,000
Aluminium .....	26.00	210 12	Lead .....	167	98 10	Copper wire No. 2 .....	266,000
Copper: electrolytic	30.00	243 0	Nickel .....	1,180	689 2	Heavy copper .....	273,000
Lead .....	10.00	81 0	Tin .....	1,620	956 1	Light copper .....	230,000
Nickel .....	70.00	567 0	Zinc: electrolytic .....	185	108 0	Brass, new cuttings .....	210,000
Zinc: Prime western	12.25	100 4				Red brass scrap .....	215,000
High grade 99.95 ..	12.85	104 17	<b>Scrap</b>				
High grade 99.99 ..	13.25	107 6	Aluminium soft sheet clippings (new) ..	305	178 2	<b>West Germany</b>	D-marks per
<b>France</b>	fr/kg	£/ton	Lead, soft, first quality ..	139	81 3	Scrap	100 kilos £/ton
Aluminium .....	2.43	179 11	Lead, battery plates ..	79	46 2	Used copper wire ..	235 214 1
Antimony 99.0 .....	2.80	206 18	Copper, first grade ..	395	230 13	Heavy copper .....	230 209 10
Cadmium .....	16.25	1,200 17	Bronze, commercial gunmetal .....	350	204 8	Light copper .....	205 186 15
Copper: electrolytic	3.37	249 0	Brass: heavy .....	285	166 8	Heavy brass .....	150 136 13
Lead .....	.97	71 13	Brass: light .....	270	157 12	Light brass .....	120 109 6
Nickel .....	9.00	665 2	Brass, bar turnings .....	285	166 8	Soft lead .....	58 52 16
Tin .....	12.39	914 2	Old zinc .....	108	63 0	Zinc .....	57 51 18
Zinc: Thermic .....	1.20	88 13			Used aluminium unsorted .....	90 81 19	
Zinc: electrolytic .....	1.28	94 11					
<b>Switzerland</b>	fr/kg	£/ton				<b>United States</b>	
Copper: electrolytic	3.00	221 14	Aluminium .....	2.50	210 5	c/lb	£/ton
Heavy copper .....	3.00	221 14	Copper: electrolytic .....	3.05	256 10	Aluminium .....	26.00 207 4
No. 1 copper wire ..	2.85	210 12	Lead .....	.85	71 9	Antimony 99.0 .....	32.50 259 0
Brass rod ends .....	2.90	214 6	Nickel .....	7.50	630 15	Cadmium .....	160.00 1,275 4
Zinc castings .....	.95	70 4	Tin .....	10.77	905 15	Copper: electrolytic .....	31.00 247 10
Lead .....	.90	66 10				Lead .....	11.00 87 13
Aluminium .....	1.70	125 12				Nickel .....	74.50 593 15
						Tin .....	111.25 886 13
						Zinc: electrolytic .....	25.50 98 12

## THE STOCK EXCHANGE

### Quiet But Firmer Conditions Reported

ISSUED CAPITAL	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 5 JUNE +RISE-FALL	DIV. FOR	DIV. FOR PREV. YEAR	DIV. YIELD	1961		1960	
				LAST FIN. YEAR			HIGH LOW	HIGH LOW	HIGH LOW	
£ 4,435,792	1	Amalgamated Metal Corporation	32/6 —6d.	11	9	6 15 6	33/9	26/3	35/-	26/6
400,000	2/-	Anti-Attrition Metal	1/3	NIL	4	NIL	1/3½	0/9	1/6	0/9
43,133,593	Stk. (£1)	Associated Electrical Industries	41/9 —1/-	15	15	7 3 9	54/10½	40/3	67/3	38/3
3,895,963	1	Birfield	64/9 —6/6	10	15½	3 1 9	78/9	45/-	51/3	29/-
4,795,000	1	Birmid Industries	92/3 —6/3	20	20D	4 6 9	103/-	71/3	74/9	56/-
8,445,516	Stk. (10/-)	Birmingham Small Arms	26/9 —3/9	17½ QT	12½	4 7 3	36/10½	24/9	30/6	18/3
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	14/6	5	5	6 18 0	14/6	13/9	17/4½	14/9
476,420	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/-	6	6	7 1 3	17/6	16/9	20/-	17/1½
* 300,000	1	Bolton (Thos.) & Sons Pref. 5%	16/6	5	5	6 1 3	16/6	13/9	16/-	14/3
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6%	17/-	6	6	7 1 3	18/-	16/6	21/1½	17/7½
18,846,647	Stk. (£1)	British Insulated Callender's Cables	58/9 —1/3	13½	13½	4 12 0	62/-	49/-	61/4½	47/-
20,456,599	5/-	British Oxygen Co. Ltd. Ord.	23/3½ cap —1/6	16D	16	2 5 9	28/4½	17/6	35/-	19/10½
1,200,000	Stk. (5/-)	Canning (W.) & Co.	15/- —1/4½	15½	25 + 2½ C	5 4 6	20/9	13/7½	19/9	13/7½
60,484	1/-	Carr (Chas.)	1/- —1½ d.	NIL	12½	—	1/7½	10½ d.	2/3	1/-
555,000	1	Clifford (Chas.) Ltd.	30/4½ —4½ d.	12	10	7 18 0	30/4½	26/-	35/-	28/9
45,000	1	Ditto Cum. Pref. 6%	15/3	6	6	7 17 6	15/3	15/1½	16/-	15/10½
300,000	2/-	Coley Metals	3/9 —3d.	15	15	8 0 0	4/5½	3/6	5/-	3/4½
10,185,696	1	Cons. Zinc Corp.†	73/— —2/9	20	15	5 9 6	81/6	64/-	80/9	59/6
5,399,056	1	Davy-Ashmore	163/9 —10/-	30½	20	1 16 9	177/6	129/6	147/3	99/6
8,000,000	5/-	Delta Metal	24/3 —2/4½	20	17½	4 2 6	27/7½	19/9	28/3	18/6
5,296,590	Stk. (£1)	Enfield Rolling Mills Ltd.	45/- —9d.	15	15	6 13 3	52/3	45/-	56/9	45/-
1,155,000	1	Evered & Co.	45/-	10B	10½	2 19 3	45/-	42/6	42/9	29/3
18,000,000	Stk. (£1)	General Electric Co.	35/- —1/9	10	10	5 14 3	39/6	29/6	47/9	29/-
1,500,000	Stk. (10/-)	General Refractories Ltd	60/6 —1/9	25	20	4 2 6	65/-	42/9	52/6	40/-
937,500	5/-	Glacier Metal Co. Ltd.	19/- —1/-	15	13	3 19 0	21/1½	13/9	16/1½	11/1½
2,500,000	5/-	Glynwed Tubes	30/3 —9d.	22½	25½	3 14 6	30/3	23/7½	27/6	17/-
7,228,065	10/-	Goodlass Wall & Lead Industries	35/9 —2/—	15	19L	4 4 0	44/9	34/9	41/9	33/-
696,780	10/-	Greenwood & Barclay	27/3½ cap	30	30	5 10 0	29/6	23/9Z	33/6	29/1½
792,000	5/-	Harrison (B'ham) Ord.	14/3 —20½	7	3 10 3	14/6	12/-	15/10½	11/9	
150,000	1	Ditto Cum. Pref. 7%	20/3 —20½	7	6 18 3	20/4½	20/-	23/6	22/-	
1,612,750	5/-	Heenan Group	15/6 —9d.	13	15	4 3 9	17/1½	10/6	13/-	9/10½
251,689,407	Stk. (£1)	Imperial Chemical Industries	75/6 —3/—	13½	11½	3 13 0	81/6	63/1½	76/6	54/-
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	15/6 —6d.	5	5	6 9 0	16/-	14/10½	18/-	15/4½
29,196,118	**	International Nickel	138½ —5	\$1.60	\$1.50	2 2 0	152½	104	105	84½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	14/-	5	5	7 2 9	14/10½	13/9	16/6	14/6
6,000,000	1	Ditto Ord.	62/3 —2/—	12	12D	3 17 0	64/3	59/6	67/6	44/9
600,000	10/-	Keith, Blackman	21/-	17½	17½ E	8 6 9	21/6	18/3	32/6	17/6
320,000	4/-	London Aluminium	14/4½ —2/—	12	10	3 6 9	15/-	8/6	12/6	7/10½
765,012	1	McKechnie Bros. Ord.	67/- —1/—	17½ F	15F	5 4 6	68/-	53/6	71/6	57/3
1,530,024	1	Ditto A. Ord.	66/6 —6d.	17½ F	5 5 3	67/-	53/3	69/3	55/-	
1,108,268	5/-	Manganese Bronze & Brass	16/-	20½	20½	6 10 0	18/6	14/-	18/6	13/4½
50,628	6/-	Ditto (7½% N.C. Pref.)	5/9	7½	7½	7 16 0	6/-	5/4½	6/6	5/9
26,361,444	Stk. (£1)	Metal Box	89/- —5/9	12M	13B	2 9 3	100/9	68/3	84/3	61/-
415,760	Stk. (2/-)	Metal Traders	8/6	50	50	11 15 3	8/7½	6/9	10/9	7/1½
160,000	1	Mint (The) Birmingham	43/-	12½	10	5 16 0	43/-	36/-	39/-	33/6
80,000	5	Ditto Pref. 6%	76/3	6	6	7 17 6	77/6	76/-	80/-	75/-
5,187,938	Stk. (£1)	Morgan Crucible A.	64/9 —3/6	14	13	4 6 9	71/3	53/4½	63/-	47/6
1,000,000	Stk. (£1)	Ditto 5½ Cum. 1st Pref.	15/6	5½	5½	7 2 0	17/-	15/3	18/9	15/9
3,850,000	Stk. (£1)	Murex	46/6 —4/-	22½	15	5 14 0	52/-	39/9	45/-	35/3
585,000	5/-	Ratcliffe (Great Bridge) Ord.	15/9	10	10R	3 2 6	16/6	15/9	17/-	14/9
195,000	5/-	Ditto 8% Max. Ord.	4/10½	8	—	8 4 0	5/-	4/10½	5/3	5/-
1,064,880	10/-	Sanderson Kayser	39/6 —6d.	35½	25	4 8 0	41/3	33/9	40/3	27/7½
1,400,500	Stk. (5/-)	Serck	18/7½xd —3d.	12½	17½ GD	3 7 0	19/3	15/-	25/6	15/3
8,035,372	Stk. (£1)	Stone-Platt Industries	59/3 —2/3	15	15	5 8 0	67/-	55/-	64/4½	52/3
2,928,963	Stk. (£1)	Ditto 5½ Cum. Pref.	15/6	5½	5½	7 2 0	18/-	15/-	18/7½	15/3
35,344,881	Stk. (£1)	Tube Investments Ord.	74/— —2/3	14	20	3 15 9	85/6	70/6	140/3	63/10½
41,000,060	Stk. (£1)	Vickers	37/3 —1/—	10	10	5 7 3	38/3	28/-	39/7½	27/1½
750,000	Stk. (£1)	Ditto Pref. 5%	14/—	6d.	5	7 2 9	15/-	12/7½	17/6	13/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	20/6	*5	*5	7 5 0 A	21/1½	19/9	24/6	20/1½
4,594,418	1	Ward (Thos. W.) Ord.	81/6 —1/6	13½	25	3 6 3	84/6	64/6	94/-	63/-
7,109,424	Stk. (£1)	Westinghouse Brake	43/3 —2/3	11	10	5 1 9	46/3	36/4½	60/6	37/6
323,773	2/-	Wolverhampton Die-Casting	10/3 —1/6	35	30	6 16 6	13/4½	9/-	13/10½	8/1½
591,000	5/-	Wolverhampton Metal	28/— —1/—	32½	27½	5 16 0	30/-	24/6	39/9	23/9
156,930	2/6	Wright, Bindley & Gell	4/7½	15	20½	8 2 3	4/7½	3/7½	4/6	2/10½
124,140	1	Ditto Cum. Pref. 6%	13/3	6	6	9 1 3	13/7½	13/3	15/-	13/6
150,000	1/-	Zinc Alloy Rust Proof	5/1½	40	30	7 16 3	5/6	4/6	5/4½	4/-

\*Dividend paid free of Income Tax. Incorporating Zinc Corp. & Imperial Smelting. \*\*Shares of no Par Value. ½ and 100% capitalized issue. The figures given relate to the issue quoted in the third column. A Calculated on £7 8 9 gross. D and 50% capitalized issue. C paid out of Capital Profits. E and 50% capitalized issue in 7½ 2nd Pref. Shares. R and 33½% capitalized issue in 8% Maximum Ordinary 5/- Stock Units. ½ and 6½% from Capital Profits B and 50% capitalized issue. G and 1½d. special distribution. F and special 5% tax free dividend. H As forecast. J And 3 for 7 capitalized issue. L and 33½% capitalized issue. M and 10% capitalized issue. N and 75% capitalized issue. S and 40% capitalized issue. O calculated at 13½%. P Calculated at 11½%. Q also 1/- special tax free dividend and 50% capitalized issue. T Per £1 unit. Z After capital reorganization \*The Thomas Bolton Ordinary Capital has been acquired by British Insulated Callender's Cables.

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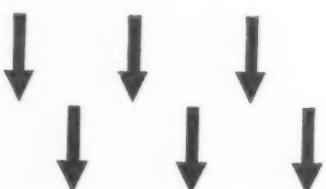
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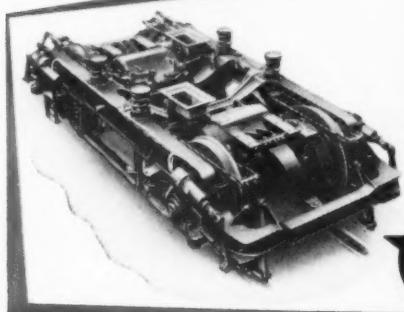
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*View of bogie showing the two motors in which Bolton's H.C. commutator segments have been used.*



CVS-564



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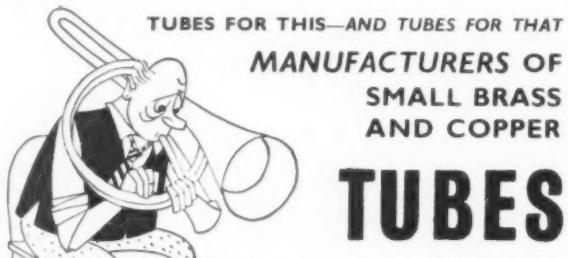
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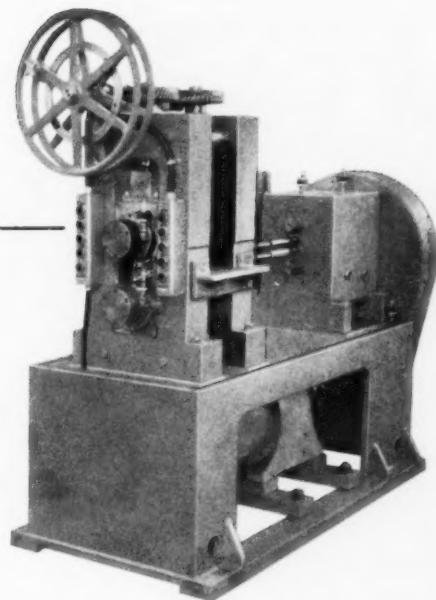
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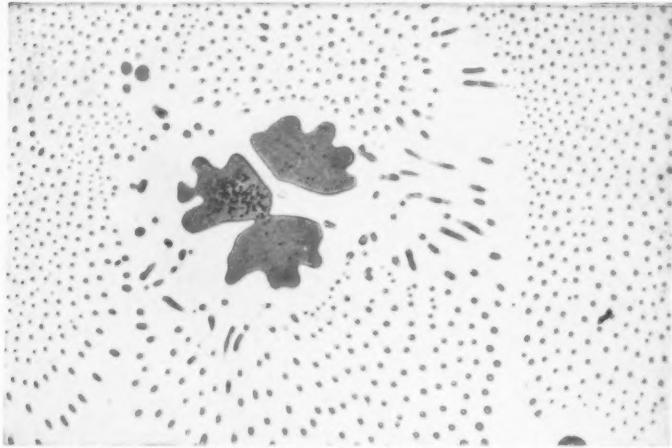


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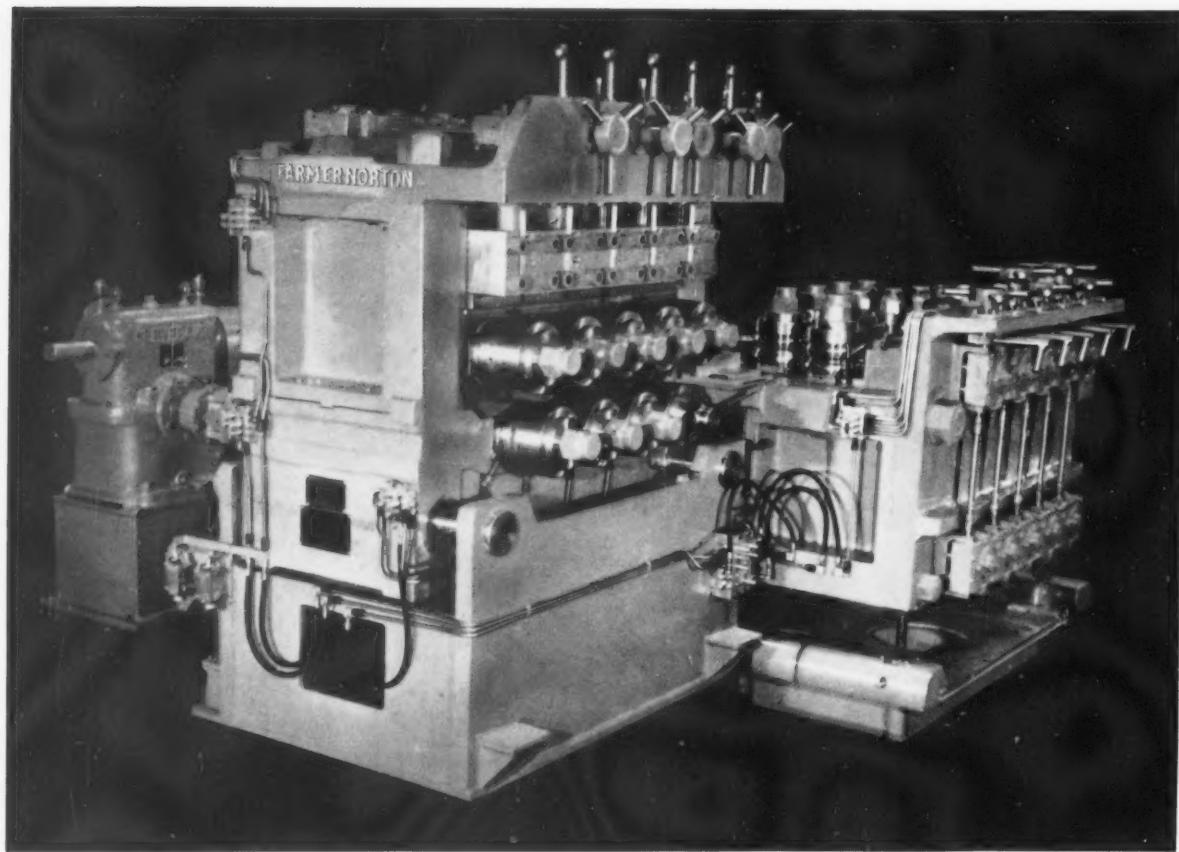
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